Reports to the President

For the year ended
June 30, 2000

MIT Massachusetts Institute of Technology

Reports to the President

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For the year ended
June 30, 2000

MIT
Massachusetts
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THE YEAR IN RETROSPECT

The academic year 1999–2000 saw extraordinary activity in all aspects of the life of the Institute—in academics, in student life, in research, in administration, and in campus development. These activities are chronicled in the reports of the individual units to the President that are gathered in this publication. Here we summarize highlights from among these achievements, using both human and statistical measures. There is no individual Report of the President this year.

IN SPECIAL RECOGNITION

The academic year 1999–2000 brought several significant changes to MIT's senior academic and administrative leadership.

Dean of Science Robert J. Birgeneau, the Cecil and Ida Green Professor of Physics, was named President of the University of Toronto, effective in July of 2000. A native of Canada and an alumnus of the University of Toronto, Dr. Birgeneau had been at MIT since 1975 and served as Head of the Department of Physics from 1988 until he became Dean of the School of Science in 1991. As Dean, he was dedicated to maintaining the essential core strengths in the scientific disciplines, while moving forward in critical emerging areas at the disciplinary interfaces. Robert J. Silbey, Director of the Center for Materials Science and Engineering and the Class of 1942 Professor of Chemistry, was named Interim Dean of Science effective February 1, 2000.

At the end of the academic year, Rosalind H. Williams, the Robert M. Metcalfe Professor of Writing, stepped down from her position as Dean of Students and Undergraduate Education to resume her research and teaching. Dean Williams played a major role in turning attention to the role of student life in the educational process and was instrumental in moving forward the recommendations of the Task Force on Student Life and Learning. Her five years as Dean were also marked by the consolidation of student services and administrative reorganization. Dean for Student Life Margaret R. Bates, who reported to Dean Williams, also announced that she would step down to join her husband on a one-year research sabbatical.

Under a new structure, the deans for undergraduate education and for student life will both report to the Chancellor. Robert P. Redwine, Professor of Physics and Director of the Laboratory for Nuclear Science, was named Dean for Undergraduate Education. A former undergraduate officer of his department, he has also taught introductory physics. As the academic year came to a close, Associate Dean Kirk D. Kolenbrander was named Interim Dean for Student Life.

Laura Avakian was named Vice President for Human Resources, succeeding Joan F. Rice, who retired in April of 1999. Previously Senior Vice President of Human Resources at CareGroup, the corporate parent of Boston's Beth Israel Deaconess Medical Center, Ms. Avakian oversees the Human Resources (formerly Personnel) and Medical departments.

John C. Crowley, Special Assistant to the President and Director of the MIT Washington Office, was named Vice President for Federal Relations. Strong, positive federal relations are essential to maintaining the excellence of the Institute's programs of graduate education and research. Dr. Crowley has been a persuasive advocate in Washington not only for MIT but for the higher education and research community nationwide.

New academic department or program leaders whose service began during the year were Isabelle de Courtivron, Head, Foreign Languages and Literature Section; John H. Harbison and Marcus A. Thompson, Interim Section Heads, Music and Theater Arts Section; Daniel Hastings, Co-Director, Technology and Policy Program; James Howe, Head, Anthropology Program; Alec P. Marantz, Head, Department of Linguistics and Philosophy; Harriet Ritvo, Head, History Section; Merritt Roe Smith, Director, Program in Science, Technology, and Society; Subra Suresh, Head, Department of Materials Science and Engineering; and David A. Vogan, Jr., Head, Department of Mathematics.

John B. Vander Sande was named MIT Co-Director of the newly established Cambridge-MIT Institute, and Michael S. Scott Morton was named MIT Associate Director for the program. J. Kim Vandiver was named Dean for Undergraduate Research. Dick K. P. Yue, Professor of Hydrodynamic and Ocean Engineering, was named Associate Dean of the School of Engineering.

Among notable changes in the administration during the past year were the appointments of Paul R. Curley, Director of Capital Construction; Jane Farver, Director, List Visual Arts Center; Deborah L. Fisher, Institute Auditor; Elizabeth M. Hicks, Director, Student Financial Services; Jamie Lewis Keith, Managing Director for Environmental Programs and Risk Management, and Senior Counsel; M. S. Vijay Kumar, Assistant Provost and

Director of Academic Computing; Karen A. Nilsson, Associate Director of Operations, Residential Life and Student Life Programs; Deborah Poodry, Director of Capital Project Development.

* * *

The honors bestowed on MIT's faculty and staff each year are a striking reminder of the outstanding quality of the Institute's teaching and research. The following summary provides only a few examples of the awards and recognition earned by members of the MIT community during 1999–2000.

Two members of the MIT faculty were among this year's recipients of the National Medal of Science. Economist and Institute Professor Emeritus Robert M. Solow was recognized for wide-ranging achievements that have influenced economics and economic policy worldwide and won him the Nobel Prize in Economics in 1987. He developed the modern framework for analyzing the effects of investment and technology on economic growth, in the process demonstrating that technology plays a much greater role in economic growth than previously understood. Kenneth N. Stevens, the Clarence J. LeBel Professor of Electrical Engineering, was honored for research in speech sciences that laid the groundwork for many of today's speech synthesis and recognition technologies. His theoretical work on acoustic properties of speech sounds that comprise the linguistics elements of language has led to the contemporary foundations of speech science, and his theoretical work on acoustic invariance has defined unifying principles that have integrated major portions of acoustic phonetics, phonology, speech science, and linguistics.

MIT reserves the title of Institute Professor for a small number of faculty members of particular distinction, who are recognized by their peers for exceptional leadership, accomplishment, and service in the scholarly, educational, and general intellectual life of the Institute and of the wider academic community. This past year, Joel Moses, the Dugald C. Jackson Professor of Computer Sciences and Engineering and former Provost, was named Institute Professor in recognition of pioneering work in symbolic computation and tremendous contributions to the administration and community life of MIT.

Two MIT professors were elected to membership in the National Academy of Sciences (NAS), one of the highest distinctions accorded within the scientific community. This year's new members from the Institute were Henry Brenner, the Willard Henry Dow Professor of Chemical Engineering, and Professor of Physics Rainer Weiss.

The National Academy of Engineering (NAE) elected three new members from the MIT faculty: Justin E. Kerwin, Professor of Naval Architecture; Nancy Leveson, Professor of Aerospace Information Systems; and Gerald J. Sussman, the Matsushita Professor of Electrical Engineering. Election to the NAE is among the highest professional distinctions accorded an engineer.

This year, two members of the MIT faculty were elected Fellows of the American Academy of Arts and Sciences: Stephen Leffler Buchwald, the Camille Dreyfus Professor of Chemistry, and Institute Professor Thomas L. Magnanti, Dean of the School of Engineering.

The Institute of Medicine, more than 20 of whose members are connected with MIT, elected to membership Nancy Hopkins, the Amgen Professor of Biology.

Historian John W. Dower, the Elting E. Morison Professor in the Humanities, became the second member of the MIT faculty to win a Pulitzer Prize when his study of Japan under American occupation, *Embracing Defeat: Japan in the Wake of World War II*, was awarded this year's prize for non-fiction. Institute Professor John Harbison was awarded the Pulitzer Prize for music in 1987.

Continuing the Institute's long tradition of national service, Institute Professor Mildred S. Dresselhaus, a past winner of the National Medal of Science and former President of the American Association for the Advancement of Science, was nominated to serve as Director of the Office of Science at the Department of Energy.

Appointment as MacVicar Faculty Fellows recognized outstanding commitment to excellence in teaching on the part of six members of the faculty: Rohan Abeyaratne, Associate Professor and Associate Department Head in the Department of Mechanical Engineering; John W. Belcher, Professor of Physics and Class of 1960 Faculty Fellow; Ernest G. Cravalho, Professor of Mechanical Engineering and Taplin Professor of Medical Engineering in the Harvard-MIT Division of Health Sciences and Technology; Dava J. Newman, Associate Professor of Aeronautics and Astronautics; Steven Pinker, Professor of Psychology in the Department of Brain and Cognitive Sciences; and Jacquelyn C. Yanch, Associate Professor of Nuclear Engineering.

Institute Professor Jerome I. Friedman was the recipient of the twenty-ninth annual James R. Killian, Jr., Faculty Achievement Award. The selection committee cited him for accomplishments including experiments that gave the first clear evidence for charged point-like constituents inside the nucleon, supporting the quark model and providing the underpinnings for the development of quantum chromodynamics. Professor Friedman, who has also made outstanding contributions to academic administration and undergraduate education at the Institute, shared the 1990 Nobel Prize for Physics with the late Henry W. Kendall, also of MIT, and Stanford University colleague Richard E. Taylor.

Associate Professor of Mechanical Engineering L. (Maha) Mahadevan received this year's Harold E. Edgerton Faculty Achievement award, which recognizes junior faculty for achievements in teaching, research, and service to the MIT community.

The Gordon Y Billard Award, recognizing individuals who have performed special services of outstanding merit to MIT, was given this year to Mary Callahan, Co-Director of the Office of Academic Services and Registrar, and Donna R. Savicki, Assistant Dean of Engineering for Administration.

* * *

At the same time that MIT celebrates the achievements and honors of its current faculty, staff and students, the Institute also recognizes the distinguished careers and lifetime accomplishments of current and former colleagues who have recently passed away. We offer gratitude for, and draw inspiration from, the enduring legacy of service and achievement they have bequeathed to MIT and to all humanity.

Jonathan Allen, Professor of Electrical Engineering and Computer Science and for 19 years the Director of the Research Laboratory of Electronics (RLE) died on April 25, 2000 at the age of 65. A pioneer in the fields of computer-aided design, speech processing and integrated electronics, he achieved widespread recognition in the 1970s for the creation of a talking, reading computer named "Morris." In later years, he developed a speech synthesizer used by such luminaries as physicist Stephen Hawking. A native of New Hampshire, he was a graduate of Dartmouth College (AB 1956, MS in Engineering 1957). After a four-year stint at Bell Laboratories, he came to MIT, where he earned a PhD in Electrical Engineering and Computer Science in 1968. He joined the faculty as an assistant professor in 1968 and was named full professor in 1975; he became associate director of RLE in 1978 and was appointed as its director in 1981. During his career, he built a global network of personal and institutional relationships that helped him, as the longtime head of his department's search committee, to recruit top faculty and graduate students from around the world.

J. Kenneth Jamieson, Life Member Emeritus of the MIT Corporation, died on September 26, 1999, at the age of 89. Raised in the Canadian frontier outpost of Medicine Hat, Alberta, he began college at the University of Alberta but transferred to MIT and took subjects in civil engineering before graduating with a degree in management in 1931. Returning to Canada in the worst years of the Depression, he began a life-long career in the oil industry. His honest and forthright style of management took him from a small refinery in Calgary to the leadership of the largest petroleum company in the world. Having held executive positions at Imperial Oil, International Petroleum, and Humble Oil and Refining, he was named President of Standard Oil of New Jersey in 1965 and Chairman and Chief Executive Officer in 1969. He retired from the company, by then the Exxon Corporation, in 1975. He served two terms on the Corporation before his election as a Life Member in 1975. His wide-ranging involvement with the Institute, including tireless service on Corporation committees, was highlighted by two decades of generous and productive work on behalf of the Department of Chemical Engineering.

William Nashe Locke, Professor Emeritus, former department head for Modern Languages, and former Director of the MIT Libraries, died on February 22, 2000 at the age of 90. A 1930 graduate of Bowdoin College, he spent several years working as a carpenter and electrician before continuing his formal education, first in Paris and then at Harvard University, where he received an MA (1937) and a PhD (1941) in linguistics. During World War II, he served with the Office of War Information. He joined MIT as head of modern languages in 1945 and served as Director of the MIT Libraries from 1956 until his retirement in 1974. A scholar of French linguistics and information science, he published widely on topics that included automated translation and the use of French in scientific literature. His work was recognized in France with Les Palmes d'Officier d'Academie in 1949 and his appointment in 1956 as a Chevalier de la Legion d'Honneur. At MIT, he expanded and modernized the structure as well as the collections of the library system. He was an early advocate of the use of computers in managing libraries and he held patents on a remote-controlled language laboratory and even a tool that combined the functions of a screwdriver and a wrench.

Charles A. Myers, Professor Emeritus of Industrial Relations and former Sloan Fellows Professor of Management, died on April 2, 2000 at the age of 87. A noted labor economist, he held joint appointments in the Department of

Economics and the Sloan School. A 1934 graduate of Pennsylvania State College, he earned his 1939 PhD from the University of Chicago. Immediately upon receiving his doctorate, he came to MIT as an instructor in economics and social science. He was appointed assistant professor of industrial relations in 1941, associate professor in 1946, and full professor in 1949. The author or co-author of numerous books on labor economic and relations, he and MIT colleague Paul Pigors collaborated on a leading textbook focusing on personnel administration. He was called upon for a wide range of government service from World War II through the end of the 1960s. A former president of the Industrial Relations Research Association and a charter member of the National Academy of Arbitrators, he served throughout his life as an arbitrator for labor disputes.

Lloyd Rodwin, Ford International Professor Emeritus of Urban Studies and Planning and co-founder of the MIT-Harvard Joint Center for Urban Studies, died at the age of 80 on December 7, 1999. He attended the City College of New York and worked with the US Defense Housing Program before being drafted during World War II. Discharged early because of poor eyesight, he earned an MA in land economics from the University of Wisconsin and a PhD in regional planning from Harvard University in 1949. Professor Rodwin was instrumental in the transformation of city planning to urban studies and the extension of its concerns to the Third World. In 1961, he led a group of planners in a seminal multidisciplinary effort to design the Venezuelan new city of Ciudad Guayana. He chaired his department from 1969 to 1973 and was instrumental in the establishment of the Special Program for Urban and Regional Studies and the MIT Community Fellows Program.

Physicist Toyoichi Tanaka, the Otto and Jane Morningstar Professor of Science, died of a sudden heart attack on May 20, 2000, at the age of 54. He achieved international acclaim for his work on "smart gels"—polymers that can be stimulated by light, temperature, or other stimuli to expand or contract, thereby capturing or releasing other materials. These unique properties make smart gels suitable for a wide range of potential applications, including the capture of oil spills and other pollutants or use as a material for artificial muscles or soft, tissue-like valves. Professor Tanaka held three degrees in physics from the University of Tokyo. He came to MIT as a research staff member, joined the faculty in the Department of Physics in 1975, and was named full professor in 1982. A highly regarded teacher who used his smart gels to create memorable classroom demonstrations, he won numerous awards and honors including a 1986 Nishina Memorial Prize, France's Vinci d'Excellence award in 1993, the 1994 Inoue Prize for Science, and a Discover Award from *Discover* magazine.

George E. Valley, Jr., Professor Emeritus of Physics and founder of MIT's Experimental Studies Group (ESG), died on October 16, 1999 at the age of 86. A 1935 graduate of the Institute, in 1939 he earned a PhD in nuclear physics from the University of Rochester and returned to MIT in 1941 to join the staff of the Radiation Laboratory, where he developed the H2X all-weather radar bombsight. He was appointed a professor of physics at MIT in 1946 and conducted research on cosmic rays as well as on defense-related projects. He conceived and helped create both the Distant Early Warning System and the SAGE computer that controlled it—work that led to service as assistant and then associate director of Lincoln Laboratory between 1949 and 1957. He served on the Air Force Scientific Advisory Board 1946–64 and was on leave from MIT as chief scientist for the Air Force in 1957–59. In 1969, he used grant funds provided by Polaroid founder Edwin Land to create ESG, which provides an alternative approach to teaching and learning for first-year students.

STATISTICS FOR THE YEAR

REGISTRATION

In 1999–2000 student enrollment was 9,972, compared with 9,885 in 1998–99. There were 4,300 undergraduates (4,372 the previous year) and 5,672 graduate students (5,513 the previous year). The international student population was 2,386, representing 8 % of the undergraduate and 36 % of the graduate populations. These students were citizens of 105 countries. (Students with permanent residence status are included with US citizens.)

In 1999–2000, there were 3,287 women students (1,768 undergraduate and 1,519 graduate) at the Institute, compared with 3,202 (1,776 undergraduate and 1,426 graduate) in 1998–99. In September 1999, 452 first-year women entered MIT, representing 43% of the freshman class of 1,055 students.

In 1999–2000, there were, as self-reported by students, 2,669 minority students (1,996 undergraduate and 673 graduate) at the Institute, compared with 2,600 (2,009 undergraduate and 591 graduate) in 1998–99. Minority students included 370 African Americans (non-Hispanic), 93 Native Americans, 554 Hispanic Americans, and 1,652 Asian Americans. The first-year class entering in September 1999 included 494 minority students, representing 47% of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1999–2000 included 1,253 bachelor's degrees, 1,457 master's degrees, 14 engineer's degrees, and 475 doctoral degrees—a total of 3,199 (compared with 3,196 in 1998–99).

STUDENT FINANCIAL AID

During the academic year 1999–2000, 2,312 undergraduates received a total of $50,275,512 in student financial aid, exclusive of student employment. The number of needy students decreased by approximately 4 % from the prior year, but the total aid increased by 2.5 %. The decline in the number of needy students is attributed to the continuing healthy economy.

Total grant assistance to undergraduates was $37,812,931, an increase of 5%. This grant assistance consisted of $17,954,336 in income from scholarship endowment, $1,587,735 in current gifts, $3,524,230 in federal grants (including ROTC scholarships), $3,414,632 in direct grants, and $11,331,998 in scholarships from MIT's unrestricted funds. The $11,331,998 in unrestricted scholarships includes $359,305 for a special program of scholarship aid to needy minority group students and $388,351 in MIT Opportunity Awards.

The total loans made to undergraduate and graduate students were $26,750,080, a decrease of 3.3% from last year.

Loans totaling $12,462,581 were made to undergraduates, a decrease of 4.4 % from last year. Of the total loans made, $1,944,584 came from the Technology Loan funds, $3,375,093 from the Federal Perkins Loan Program, and $7,142,904 from the Federal Direct Loan Program. Lower student borrowing is attributed to MIT's new policy on the treatment of outside awards—which allows the outside award recipient to use the award to reduce their student loan and/or student employment.

Graduate students received a total of $14,287,499 in loans, representing an increase of 2.3 % from last year. This total included $4,954,865 from the Technology Loan funds, $7,750,476 from the Federal Direct Loan Program and $1,582,158 from the Federal Perkins Loan Program.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

In 1999–2000, the market for MIT graduates continued to be robust in every area of industry, and the demand for MIT students was very competitive. Many employers made offers during the fall semester, and students found themselves deciding between offers earlier than in years past. The strong pace of activity in the fall led many employers to cancel their traditional spring visits; accordingly, the number of individual employers interviewing at MIT actually declined despite the strong market for graduates. Interview schedules for the coming academic year suggest that the fall will again be very busy.

Software skills continued to be the most sought-after single area of student expertise, and employers were willing to interview students with substantial experience in information technology regardless of course affiliation or degree level. Students in all courses have shown a strong interest in working for start-up companies, especially in Ecommerce, information technology, and communications. Among established companies, the biotechnology and pharmaceutical sectors and the business side of technical industries remain popular.

Starting salaries have increased, as have the percentage and range of firms offering signing bonuses. Salaries for doctoral graduates in engineering range on the average from $70,000 to $90,000, offers to master's candidate's range from $55,000 to $70,000, and to bachelor's candidates from $45,000 to $54,000.

In 1999 applicants to medical school included 87 seniors, of whom 83% were admitted, and 8 graduate students, of whom 75% were admitted. A total of 70 MIT alumni/ae applied to medical school, of whom 59 % were admitted. Taking undergraduates, graduate students, and graduates together, a total of 66 men and 99 women applied to medical school; the acceptance rate for all 165 applicants was 72%, substantially ahead of the national acceptance rate for all applicants of 45 %.

PRIVATE SUPPORT

Private support for fiscal year 2000 totaled $233.6 million and included the following: $226.5 million in gifts, grants, and bequests, and $7.1 million in support through membership in the Industrial Liaison Program. The total compares with $209 million in 1999, $143.9 million in 1998, $133.6 million in 1997, and $130.9 million in 1996. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $12 million.

By source, gifts from alumni totaled $113.2 million; non-alumni friends, $23.6 million; corporations, corporate foundations, and trade associations, $59.2 million; foundations, charitable trusts, and other charitable organizations, $28.7 million; and others, $1.8 million.

FINANCES

The Institute's financial results were favorable during fiscal year 2000. Unrestricted revenues available for operations totaled $1.3 billion. Total operating expenses were $1.3 billion. Net assets increased $2.7 billion reaching $8.2 billion at year-end. The MIT endowment reached a market value of $6.6 billion, and benefited from very favorable investment returns and a record level of gifts and pledges.

The research revenues of departmental and interdepartmental laboratories, primarily on campus, totaled $379.9 million in fiscal year 2000, a decrease of 2.7% from the prior year. Industrial sponsors as a group remained the largest source of sponsored funds at MIT, followed by the Department of Defense and the National Institute of Health. Lincoln Laboratory reported revenues of $348.3 million, a decrease of 1.4%.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

The Institute expanded its recycling program this year through the efforts of the Environmental Programs Task Force. This group of volunteers from departments across MIT, as well as student representatives, is working to initiate or broaden environmental activities on the campus. MIT community members are now recycling mixed paper, cans, bottles, and many plastics in special bins located throughout the campus.

A new administrative area was created by the Executive Vice President this year, and several offices were reorganized. The Environmental Programs Office (EPO) was created in July to take responsibility for overall environmental, health, and safety (EHS) management at the Institute. In February, all of the offices charged with providing services and oversight to the MIT community on EHS issues were reorganized into a single team that reports to the Managing Director for Environmental Programs and Risk Management and Senior Counsel, who heads the EPO. The EHS team comprises the new Environmental Management Office, the Safety Office, and the Environmental Medical Service. In the past, these offices had overlapping responsibilities and shared jurisdiction as well as different reporting structures. The new organization creates clearer accountability and responsibility for each of the many regulatory programs that govern MIT's work and is designed to provide more effective service to the Institute.

There was a great deal of activity to lay the groundwork for the increasing volume and complexity of construction and renovation projects on campus. As part of this preparation, the functions of the Planning Office were reorganized to align the staff more closely with the departments and business processes that rely upon their technical expertise. Members of the Planning Office staff were reassigned to the Department of Facilities and the Offices of the Dean of Students and Undergraduate Education, the Executive Vice President, and the Provost.

Within the Department of Facilities, the management of the Capital Projects Group was reconfigured, and MIT hired both a Director of Capital Development and a Director of Capital Construction. These two staff members are responsible for ensuring that the flow between project development and construction is a coordinated, disciplined, and smooth process.

Work began this year on the construction of the Ray and Maria Stata Center for Computer, Information and Intelligence Sciences, which was designed by architect Frank O. Gehry. The groundbreaking for this 350,000 square foot facility was held in March, and construction is expected to take four years.

Construction of the 350-bed undergraduate dormitory on Vassar Street, originally scheduled to open in the fall of 2001, was delayed by an appeal filed by the owner of an adjacent property. Due to the delay, freshmen will not be required to live on campus in the fall of 2001, as previously planned. The policy to house freshmen on campus is now tentatively scheduled to go into effect in the fall of 2002, pending completion by then of the new residence hall.

Construction on the new sports and fitness center is scheduled to begin in fall 2000. This new facility, to be built between the existing Johnson Athletics Center and the Stratton Student Center, will include a 50-meter pool, seating for approximately 450 spectators, recreation and team locker rooms, a health fitness center, and a sports medicine training facility.

Work on providing additional housing for graduate students is progressing. A complete interior demolition and significant design development of NW30, at 224 Albany Street, was completed this year. This site will provide housing for about 120 graduate students by the fall of 2001. Planning has also begun for a new graduate residence at Sidney and Pacific streets for approximately 600 to 700 students.

Other major new projects will include an expansion of the Media Laboratory, which is currently in design development.

Renovation highlights of the year included major work to upgrade office and laboratory space in Building 33 for the Department of Aeronautics and Astronautics. Life safety and other systems were replaced in Kresge Auditorium, the Chapel, East Campus, and Random Hall. Renovations to accommodate the Center for Learning and Memory in Buildings E17 and E18 are continuing. The Central Utility Plant is being expanded to support the Stata Center and other new facilities on campus. In addition, three classrooms were completed on the first floor of Building 1, and the mechanical systems were upgraded to provide a new standard for general-purpose classrooms.

Work continues on a comprehensive upgrade of facilities for the Department of Chemistry. Construction is nearly complete on the third and fourth phases of this plan, in Buildings 2, 4, and 6. An extensive three-year renovation of the Dreyfus Building began in the spring. Laboratory facilities and infrastructure will be renovated and modernized in order to meet today's research demands and to enhance life-safety systems.

Renovation of property at 304 Vassar Street will provide approximately 50,000 square feet that will be occupied by Financial Systems Services and Information Systems.

PERSONNEL CHANGES

CORPORATION

Deaths
J. Kenneth Jamieson
Member

Retirements
Herbert P. Wilkins
Member

Resignations
Gerherd H. Schulmeyer
Member

Changes Of Appointment
Edward E. David, Jr.
Life Member, Emeritus

James A. Levitan
Life Member, Emeritus

Frank Press
Life Member, Emeritus

Emily V. Wade
Life Member, Emeritua

Elections
Gordon M. Binder
Member

Dedric A. Carter
Member

John K. Castle
Member

Gururaj Deshpande
Member

Arthur Gelb
Member

Barbara A. Gilchrest
Member

Brian G. R. Hughes
Member

James A. Lash
Member

Judy C. Lewent
Life Member

A. Neil Pappalardo
Life Member

Kenan E. Sahin
Member

Linda C. Sharpe
Member

John A. Thain
Member

Member Ex-Officio
Margaret M. Marshall
Chief Justice of the Supreme Judicial Court of Massachusetts

Paul Rudovsky
President, Association of Alumni and Alumnae

Term Expired
George N. Butzow
Member

John M. Hennessy
Member

Mark E. Lundstrom
Member

Antonia D. Schuman
Member

R. Gary Schweikhardt
Member

FACULTY

Deaths
Jonathan Allen
Professor/Director
Research Laboratory of Electronics

Richard Beckhard
Adjunct Professor
Sloan School of Management

William N. Locke
Professor
Foreign Student Advisors

Charles A. Myers
Professor
Sloan School of Management

Lloyd Rodwin
Professor
Department of Urban Studies and Planning

Toyoichi Tanaka
Professor
Department of Physics

George E. Valley, Jr.
Professor
Department of Physics

Retirements
Carl E. Hewitt
Associate Professor
Department of Electrical Engineering and Computer Science

Winston R. Markey
Professor
Department of Aeronautics and Astronautics

Satoru Masamune
Professor
Department of Chemistry

James R. Munkres
Professor
Department of Mathematics

Resignations
Professor
Paul R. Krugman
Professor
Department of Economics

Hidde Ploegh
Professor
Department of Biology

Jeremy C. Stein
Professor
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Associate Professor
Aaron F. Bobick
Associate Professor
Program in Media Arts and Sciences

Sergey Fomin
Associate Professor
Department of Mathematics

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Associate Professor
Department of Earth, Atmospheric, and Planetary Sciences

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Theodore T. Miller Career Development
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Department of Economics

Stuart Gordon White
Assistant Professor
Department of Political Science

Lora J. Wildenthal
Assistant Professor
History Section

Promotions
To Professor
Dennis Adams
Professor
Department of Architecture

Stephen D. Ansolabehere
Professor
Department of Political Science

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Gail E. Kendall Professor
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Professor
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Professor
Department of Physics

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Department of Urban Studies and Planning

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Department of Urban Studies and Planning

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Department of Political Science

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Sloan School of Management

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Professor
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To Associate Professor
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Department of Physics

Susan Athey
Associate Professor
Department of Economics

Paul I. Barton
Associate Professor
Department of Chemical Engineering

Michael P. Brenner
Associate Professor
Department of Mathematics

John G. Brisson, II
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Department of Mechanical Engineering

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Department of Linguistics and Philosophy

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Department of Civil and Environmental Engineering

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Department of Architecture

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Department of Political Science

Feniosky Pena-Mora
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Department of Political Science

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New Appointments
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Department of Economics

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Visiting Associate Professor

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Visiting Assistant Professor
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Department of Architecture

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Department of Economics

Michele Lanzetta
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Department of Mechanical Engineering

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Department of Electrical Engineering and Computer Science

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Austin Parsons
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Department of Architecture

Bernt D. C. Schiele
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Program in Media Arts and Sciences

Hassan Shibly
Visiting Assistant Professor
Department of Mechanical Engineering

ADMINISTRATIVE

Deaths
Paul L. Bergonzi
CEO/Treasurer
Credit Union

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Department of Facilities

Philip Cope
Assistant Director, Stores
Office of Laboratory Supplies

Ralph V. Jackson
Route Supervisor, Building Services
Department of Facilities

Guy J. Morac
Administrative Assistant, Food Services
Housing

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Associate Head Librarian
Libraries

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Staff Writer/Editor
News Office

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Benefits Counselor
Human Resources

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Coach, Repair and Maintenance
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Resignations
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Student Financial Services

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Safety Office

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Housing

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Museum

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Associate Intellectual Property Counsel
Vice President for Research

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Fine Arts Registrar
List Visual Arts Center

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Office of the Dean for Undergraduate Education

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Service Process

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Student Services Information Technology

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Li-Hui Chen
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MIT Press

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Lincoln Fiscal Office

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Ilse Evans
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PROVOST

Many milestones marked Academic year 2000. There were significant advances in academic and educational programs, faculty hiring, research support and the financial management of MIT. Some of these developments are described in this summary. These and other developments are described in the reports of programs, departments, and schools.

Several appointments were made to the Academic Council in AY 2000. Dr. Isaac M. Colbert was appointed Dean of Graduate Students. Dr. Colbert previously served as Senior Associate Dean of the Graduate School, as well as Acting Dean. Professor Steven R. Lerman, Department of Civil and Environmental Engineering, was appointed Chair of the Faculty. He replaced Professor Lotte Bailyn of the Sloan School of Management who completed her two-year term.

MIT lost the service of an outstanding academic leader and administrator when Professor Robert Birgeneau resigned as Dean of Science to become President of the University of Toronto. Professor Robert J. Silbey, Director of the Center for Material Science and Engineering, is serving as Interim Dean while a search is underway for a new dean. It is with sadness that we record the passing of Professor Jonathan Allen of the Department of Electrical Engineering and Computer Science and Director of the Research Laboratory for Electronics. His leadership will be missed.

Another appointment of note was that of Dr. Vijay Kumar as Assistant Provost and Director of Academic Computing. As part of an administrative reorganization, Ms. Lydia Snover joined the Provost's Office as Assistant to the Provost for Institutional Research.

FACILITIES

The Institute continued its commitment to aggressive renovation of physical facilities and to the construction of new facilities. The process for prioritizing and planning space renovations is led by Chancellor Larry Bacow who is Chair of the Committee for Review of Space Planning (CRSP). In fiscal year 2000 MIT allocated over $24 million in funds for this purpose. Several major renovations were begun in AY 2000. These include the staged renovation of the Dreyfus Chemistry Building, Building 18, and the renovation of Building 33 for research and teaching facilities for the Department of Aeronautics and Astronautics. The third-year of a long-range plan for renovation of the classrooms in the main complex also was concluded.

In the spring of 2000 MIT broke ground on the construction of the Ray and Maria Stata Center. This approximately 420,000 square foot facility will be the home of the Laboratory of Computer Science, the Artificial Intelligence Laboratory, the Laboratory for Information and Decision Systems and the Department of Linguistics and Philosophy. The Stata Center will also house a major childcare facility, teaching facilities and significant social space for students, staff and faculty.

The Stata Center is only one of the new construction projects underway. The Media Laboratory is being expanded by the addition of the Ozawa Center for Future Children, which is being designed by the architect Fumihiko Maki. The building will be located adjacent to the Wiesner building at the corner of Ames and Amherst streets. The project is entering schematic design with construction scheduled to begin in late in 2001 on the site of the existing building E10.

A new undergraduate residence is being designed by architect Steven Holl to be located on Vassar Street. The dormitory will house 350 undergraduates and the added capacity makes it possible to assign on campus housing to all incoming freshman. The construction documents for the design are near completion and construction will begin as soon as permitting for the construction site is completed.

MIT also is moving forward on increasing the amount of housing for graduate students. This includes the creation of a new graduate residence for 120 students at 224 Albany Street (NW30). This facility will be ready for occupation in fall 2001. Design also is underway for a new graduate residence for 600-750 students at the corner of Sydney and Pacific Streets.

Finally, the final planning for the Sports and Fitness Center have been completed and groundbreaking is scheduled for October of 2001.

Planning for facilities has been greatly aided by the work of the Olin Partnership on the creation of a new master plan for MIT. This process began with a charette in 1999 and will be completed in 2001.

FACULTY AND ACADEMIC PROGRAMS

Faculty recruitment continued at a vigorous level as departments continued to recruit faculty to fill openings created by the 1996 early retirement program. In Academic Year 2000, 39 faculty were hired at untenured ranks and nine tenured faculty were recruited. Of these (tenured and untenured) 13 are women and three are minorities. During 2000 23 MIT faculty were awarded tenure within MIT. Of these, five were women. The recruitment of minority faculty remains extremely challenging.

Efforts to recruit women faculty and to enhance their mentoring and careers were moved forward with the creation of women's committees in the five schools under the oversight of the provost. With the leadership of Professor Nancy Hopkins of the Department of Biology and Lotte Bailyn of the Sloan School of Management, funding for several faculty initiatives has come from the Ford and Atlantic Philanthropic Foundations. The efforts of the women committees are being aided by Marsha Orent, staff to the committees.

The Institute also expanded its commitment to the career development of untenured faculty by starting a program of junior faculty research leaves to give untenured faculty a semester to concentrate totally on research and scholarship.

MIT continued to expand its programs with new graduate degree offerings in several areas. Of special note is the Masters of Engineering Program in Biomedical Engineering offered by the Division of Bioengineering and Environmental Health (BEH). This program is meant as a capstone professional degree for MIT undergraduate students who are interested in a career in biomedical engineering or healthcare and is built on the Biomedical Engineering Undergraduate minor offered through BEH.

MIT also continued to expand its efforts in neuroscience. The generous gift by Patrick and Lore McGovern this year led to the establishment of the McGovern Institute for Brian Research (MIBR) as a research institute within MIT. The MIBR will bring together faculty with varied backgrounds to work on important problems in neurobiology, systems neuroscience and cognitive science. Professor Phillip Sharp will be the founding Director of the MIBR.

The Dr. Martin Luther King, Jr. Visiting Professor Program had eight visiting faculty during the academic year and had a significant impact on increasing diversity among the faculty and teaching staff. Efforts are underway to increase the number of visitors in this important program.

Six new Margaret MacVicar Faculty Fellows were named this year: Professors Rohan Abeyaratne of the Mechanical Engineering Department, John Belcher of the Department Physics, Ernest Cravalho of the Department of Mechanical Engineering, Dava Newman of the Department of Aeronautics and Astronautics, Steven Pinker of the Brain and Cognitive Science Department and Jacquelyn Yanch of the Chemical Engineering Department.

FINANCES

Fiscal year 2000 represented the completion of the budgetary cycle begun in 1998, which included a new process of budget approval by the Executive Committee of the Corporation, coupled with a larger distribution of funds from the endowment. The Fiscal Year financial performance was on-budget, closing with a small (approximately $2 million) surplus. This budget included funds for the renovation program, less income from graduate tuition, and funding of the presidential graduate fellowship program.

The financing of operations was greatly aided by continued performance of the Institute's investments. The endowment began fiscal year 2000 at $4.3 billion up from approximately $1.4 billion in 1990. Although the final returns for fiscal year 2000 are not yet available, we expect another exceptional year.

Fiscal Year 2000 also marked the launching of the MIT capital campaign to raise $1.5 billion in endowment and expendable gifts. The campaign officially began on November 6, 1999 and was launched by the magnificent gift by Dr. Kenan Sahin of $100 million. The campaign total stood at just under $1 billion at the end of the year. In a related event, the Biology Building 68 was named in honor of David Koch,'62 in recognition of his generosity to the Department of Biology and MIT.

The budget for fiscal year 2001 continues to be aggressive with respect to reliance on income from the endowment and on gifts from private sources. We believe that this change represents an important step in the evolution of the

Institution away from a exceedingly heavy reliance on federal support. The capital campaign is an important next step in this evolution; its success will play a major role in the ability of MIT to continue to aggressively modernize our facilities and to remain competitive for recruiting the best faculty and students.

Planning and budgeting for the continued excellence of MIT remains a major focus. Starting with planning for Fiscal Year 2001 budget proposals will include reporting of all funds used within each academic unit—both institute general budget, endowment income and other funds— in an effort to better reconcile budget priorities.

EDUCATION

Academic Year 2000 saw several major developments in educational programs at MIT. Most notably, the MIT faculty approved a new communications requirement for all undergraduate students at MIT. The new communications requirement will include both written and oral components and will be integrated into all four years of education.

The year also saw the launch of a number of important developments in education. The gift of $10 million from Brit and Alex d'Arbeloff was used to launch a suite of experiments in education focussed on the freshman year experience. The I-campus partnership with Microsoft also began funding experiments in the use of information technology in education. Both of these initiatives have been organized with the added planning of the MIT Council on Educational Technology (MITCET), which was established to advise the senior administration on strategic issues involving information technology and to help select major initiatives and monitor progress.

The MITCET has carried out a strategic planning exercise focussed on how best to develop distance education technology focussed on continuing education for our alumni and partners. This planning will end in fall of 2000 with several specific recommendations for specific experiments and programs. The Educational Media Creation Center (EMCC) was established in 1999 to focus our efforts on developing robust and sustainable software platforms for building web-based education tools. Several of the programs within the I-Campus and d'Arbeloff initiatives are being developed by the EMCC.

In the fall of 1999 the first subjects began in the distance education program between MIT and the two major universities in Singapore, National University of Singapore and Nanyang Technological University. The program, referred to as the Singapore/MIT Alliance (SMA), involves five professional masters programs in engineering and doctoral research education co-taught by MIT and Singapore faculty, with most of the MIT teaching being delivered by a combination of synchronous and asynchronous communications technology. The first two programs in advanced materials and high performance computing were launched in summer of 1999. The first group of master's students graduated from this program in July 2000 from the National University of Singapore. A program in manufacturing began in July 2000. The support for education and research from the Singapore-MIT Alliance continued to grow. This partnership will bring almost $7 million per year in research support to MIT once the program is fully funded in 2001.

MIT and Cambridge University of England have entered into a historical cooperation called the Cambridge-MIT Institute (CMI). The CMI will sponsor faculty and undergraduate student exchanges, as well as joint teaching using distance education technology. The CMI program is entering its planning stages and will begin in earnest in fall 2001.

RESEARCH

MIT remains the preeminent research university combining world-leading research across a spectrum of disciplines with intense undergraduate and graduate education. Efforts in Fiscal Year 1999 have continued to focus on securing increased federal support of research and increasing research support from corporations, foundations and international sources to diversify the support of our programs. Several new industrial partnerships were launched in 2000. These include Microsoft, Dupont, Nanovation, and Hewlitt-Packard, each representing commitments in excess of $3 million per year in support. These partnerships join existing relationships with Merrill-Lynch, NTT, Ford, Amgen and Merck.

These efforts and the continual strength in federally supported research led to a modest increase in sponsored research on campus, which was up 2.1% to $384 million in fiscal year 2000 from $376 million in 1999. More importantly, the portion of this research volume bearing Financial and Administrative (F&A) Costs rose 5% in fiscal year 2000 to $179 million. The Federal government continued to dominate this budget, accounting for

approximately $301.6 million or 78.5%, followed by industry at $61.5 million or 16% The Lincoln Laboratory research volume in Fiscal Year 2000 was $348.3 million, down slightly from Fiscal Year 1999 at $353.3 million.

This report marks the completion of my second year as provost.

Robert A. Brown

CENTER FOR ADVANCED EDUCATIONAL SERVICES

The Center for Advanced Educational Services (CAES) is the fulcrum for MIT's efforts in distance learning, technology-enabled education, media production and delivery, and in non-degree lifelong learning—both on and off campus. The missions of CAES, encompassing education, research, and service, are:

- To design and conduct significant experiments in technology-enabled learning, using pedagogical models made feasible by the new technologies.
- To provide a wide range of technical multimedia and video services to the broader MIT community.
- To create and distribute MIT educational offerings within MIT and world-wide, often using technologies facilitating synchronous and asynchronous distance learning.
- To provide lifelong learning opportunities to practicing engineers and managers, both on and off-campus.
- To undertake research and development in the application of computing and communication technologies directed toward the goal of improving the effectiveness and productivity of learning and teaching.

CAES has assembled under its 'umbrella' six operating units that harness the talents of faculty and staff in technology-enabled education, media production and delivery, and lifelong learning. We are unaware of any other institution of higher education that has the breadth and depth of capability in these areas within one integrated facility. This allows CAES to undertake complex multifaceted projects requiring talent and technology from several of its units at one time, usually under the guidance of a full time project manager. CAES is structured as a holding company of individually managed operational units and interacts with schools, departments, centers, and laboratories Institute-wide. CAES is an integral player in the delivery of educational content with various MIT partners as described below.

Our two academic units are the Advanced Study Program (ASP)—created in the early 1960's—and the Professional Institute (PI) which is celebrating its 51st Anniversary year. The ASP, led by Ted Korelitz, serves domestic and foreign students who wish to further their education, usually after receiving their undergraduate degree, but for whom matriculating towards a Masters or Ph.D. is not immediately envisioned. Academic credit and a certificate are given to those completing MIT courses on-campus and via distance learning. The PI offers a non-credit continuing education curriculum of 50-60 three to five day long programs each summer in the areas of Computer Sciences, Systems, Design, Materials, Control, Biotechnology and Management. For the past three years it has also offered a smaller Winter Session.

Our research and development unit is the Center for Educational Computing Initiatives. CECI, headed by Professor Steven Lerman, advances the state-of-the-art and state-of-the-practice use of computation and communication technologies for learning and teaching. Founded in 1991, it joined CAES in 1995.

There are three units that create, deliver, and maintain various multimedia content. MIT Video Productions (MVP) provides a broad range of video recording and editing services. MVP, directed by Lawrence Gallagher, maintains and operates broadcast, post-editing, video-server and web-streaming technologies in our newly created electronic classrooms. The Educational Media Creation Center (EMCC), launched last fall, focuses on production of web-based interactive courseware and architecture. EMCC administratively housed in CAES and is a joint effort in conjunction with Academic Computing, headed by Dr. Vijay Kumar. The EMCC is co-directed by Richard Larson and Vijay Kumar. Lastly, digitization and compression, Internet2, and video-server retrieval of any archived programming is managed by the Streaming Media and Compression Services (SMCS). SMCS, directed by David Mycue, and formerly reported in this report as the Digital Information Technology Systems Facility, is now fully operational and works in parallel with MVP and EMCC.

CAES educational offerings have benefited learners of all ages. These include K-12 learners who download world-wide news from our web-site video archives, on-campus students who are beginning to see the fruits of our labors in on-campus technology-enabled learning, and lifelong learners who take MIT subjects and programs either on-campus or via distance learning.

HIGHLIGHTS

Fiscal Year 2000 was the fourth full year of operation of the new CAES. Highlights include:

- Best financial performance to date of the new CAES, with significant funds transferred back to MIT.
- Completion of PIVoT, Physics Interactive Video Tutor, our flagship product in on-campus technology-enabled education.
- Formation of the EMCC, with CAES' former Hypermedia Teaching Facility (HTF) being a major asset placed into the EMCC.
- Successful completion of the first full year of operation of the Singapore MIT Alliance distance learning program.
- Acceptance by MIT of a radically new design using fiber optics to centralize at CAES control, support and distribution of MIT's distance learning programming.
- National recognition of our leadership role in technology-enabled education, exemplified by invited professional presentations and congressional testimony.

Additional details provide more evidence of the exciting year that CAES has just completed.

Reflecting the exponentially growing importance of streaming media in education, MVP has continued to be the fastest growing unit in the Center. Last year MVP experienced a 40% increase in services provided as measured by revenue billed.

The SMA program may be the world's most ambitious point-to-point distance learning program. It offers up to six hours a day of direct live connectivity between our Cambridge, Massachusetts campus to one or two campuses in Singapore – at the National University of Singapore (NUS) and at Nanyang Technological University (NTU). A team of CAES technical staff, working closely with SMA Director Mert Flemings and Deputy Director Tony Patera, completed the first full academic year of synchronous delivery of two degree tracks of the MIT/Singapore Alliance (SMA). The live signal was dual streamed (video and data) through Internet2 from the Triad in Building 9. Round-the-clock learning was supported by an interactive web-site and asynchronous video streaming maintained by the EMCC. SMA Internet2 delivery had a success rate of 98%. Considering the size and complexity of the SMA program, we are unaware of any other comparable *production* use of Internet2.

During the fall 1999 semester, a "beta release" of PIVoT was offered to all 800+ MIT freshmen who registered for the core subject 8.01- Newtonian Mechanics, AKA "Physics 101." We are proud to report that the highly complex web-site, fed from three different servers and incorporating over 60 hours of digitized video, did not crash once during the entire fall semester. Even more importantly, the 8.01 students, in an extensive evaluation, reported that PIVoT helped them significantly in understanding what has traditionally been the most difficult subject for MIT freshmen.

Other CAES highlights:

Apart from the multimedia production services already mentioned in this report, MVP also provides the same services to any MIT department, laboratory, or center that needs in-house technical expertise and broadcast, videoconferencing or distance learning facilities. MVP produced many scripted and finely edited short programs. A sampling includes:

- *Biomaterials and How They'll Change Our Lives* with Robert Langer (distributed via the Alumni Association streaming web page)
- CAES Digital Road Show *(premiered in March, 2000)*
- *Educating for the Future* (premiered at the Microsoft Alliance signing)
- *Flesh, Machines and the Physical World* with Rodney Brooks
- *Remembering Margaret MacVicar* (premiered in December 1999)
- *Singapore-MIT Alliance* (premiered at Fall '99 SMA Board meeting)
- *Spheres* (produced and distributed as a Video News Release)
- *Perspectives of MIT* (premiered at the Millennium Ball)
- *Civil and Environmental Engineering Anniversary Symposium* (Videotaped, edited, digitized and distributed via CD –ROM)

The MVP Director provided a leadership role in the renovation and technical support of the Institute's distance education classrooms and facilities. MVP initiated a plan that will result in distance education facilities throughout the Institute being centrally controlled from Building 9. This ambitious plan will result in a significant saving of

classroom real estate, transmission equipment and technical support. We plan on connecting to several more classrooms over the next few years.

The PIVoT Project is nearing its completion. It was used extensively the past year in 8.01 and will continue to be a core resource in that subject for the foreseeable future. A major addition to PIVoT this past year was Prof. Lewin's 8.01 class lectures; lectures were videotaped during the fall 1999 semester. The 35 taped hour-long lectures were digitized by SMCS and posted to the PIVoT site during the semester, with a one-week delay following each live lecture. Some students reported an enhanced ability to listen to and absorb the lectures as they were delivered, rather than needing to concentrate on taking notes, as they knew they would be able to review the lectures later at their own pace from the PIVoT site. In the future, lectures will be available on PIVoT both in their entirety and as shorter, easy-to-access video segments.

The Physics Video Tutor project (PIVoT) team has embarked on a three-year collaboration with the National Center for Accessible Media (NCAM) at the WGBH Education Foundation to research web-accessibility for deaf and blind users. This research, funded by the National Science Foundation and the Mitsubishi Electric America Foundation, will explore ways to create video captions displaying symbols and equations for deaf users, narrated video descriptions for blind users, and best practices in overall site design for optimum web-access by all users.

The evaluation of our students' use of 8.01 of the beta version of PIVoT was directed in Fall 1999 by Dr. Alberta Lipson, Associate Dean of Educational Research. The purpose of this study was to learn about the web-site's functionality, student usage patterns, student attitudes toward PIVoT, and whether use of the web-site had any impact on final physics grades. A student survey was conducted last November; it was completed by 45% of enrolled students. A follow-up small focus group was organized in December. User data was collected both in logs that recorded access to the web-site, and in the PIVoT database, which recorded how many times various media elements were requested. The results of the evaluation indicate a notably favorable experience among students who used PIVoT and have been summarized in a report that is available upon request.

CAES is the home for three of the current Microsoft I-Campus initiatives. The first, headed by Prof. Peter Donaldson, focuses on the use of Microsoft Research's prototype of video commenting software in teaching Shakespeare. The second project, directed by Prof. John Belcher, will completely revise the teaching of 8.02. The D'Arbeloff Fund and the School of Science also support this second initiative. The third, directed by Professor Richard C. Larson, is "Inventing the Global Campus." CECI, the R&D arm of CAES, is the central point for all of this research.

SMA Spring survey of students showed a high level of satisfaction with the technical delivery of the program. During the past year, a second distance-learning classroom, Room 1-390, was specifically redesigned for SMA purposes, and is expected to go on-line in September 2000.

The Educational Media Creation Center (EMCC) was announced to the MIT community in the fall of 1999. This year has been a foundation-setting one, with a focus on defining the mission, establishing and building a team, and building reference design architecture while taking care of established projects. The reference design architecture encompasses the requirements of and approaches to supplying the application platforms needed to meet the production demands for sustainable, qualified web-based educational materials. Also, the second floor of Building 9 is being extensively renovated to house EMCC, starting in Sept. 2000.

The Summer 1999 registration in Professional Institute (PI) programs was disappointing at 907 registrations. Summer 2000 will have about 1100 registrations, which is in the normal range. Factors impacting the 1999 enrollments included: many Program brochures were mailed late; several sectors had poor business conditions: fibers, textiles, chemical processing, petroleum, the Pacific Basin and Latin America; and a general apprehension about Y2K. 25 major U.S. universities reported a 25% drop in 1999 summer session enrollments. Much was attributed to supervisors' reluctance to be without their full staffs in case of unforeseen problems. The Winter 2000 session continued at a modest rate, in the pattern of earlier years. PI continues the effort to expand it.

Now in the fourth year of alliance with PBS/The Business and Technology Network (a subsidiary of NTUC—National Technological University Corporation), CAES continues to produce non-credit short courses for distribution on the network. Course distribution is simultaneously produced in three formats: a) live satellite broadcast with web-site; b) videotapes with web-site and c) video-streaming with web-site. New programs this year included: *EBusiness 2000* (co-taught by a group of faculty from the Sloan School (Erik Brynolffson, Thomas

Malone, Stuart Madnick, Chrysanthos Dellarocas, and James Short), *Java Revolution* (Steven Lerman and V. Judson Harward) and *Integrated Supply Chain Management* (updated version, with Jeremy Shapiro). Other PBS/NTUC courses repeated live broadcast earlier and rebroadcast by video-stream included: *Internet Commerce, Advanced Internet Commerce, Optimizing the Supply Chain, Revenue Management, Use of Information Technology in Project Management.* Certificates of completion were issued to 700 learners during this reporting period.

The ASP recorded more in accordance with past performance, largely due to two factors: increased enrollment in the on-campus programs (84 Fellows for FY1999–2000 vs. 69 Fellows for FY1998–1999); and introduction of the Distance Learning courses in Systems Dynamics. Total enrollment for the whole period almost doubled in large part due to the series of courses offered by Senior Lecturer James Hines and others. The strong economy and different marketing strategies contributed to the increase in the number of Fellows this past year.

SMCS completed its first full year of operation. In addition to supporting our major projects, as already reported herein, including the Jewish Women's Archive, the Shakespeare Electronic Archive, and Calculus Revisited with Herb Gross. Streaming video and live webcasts of lecture series also grew dramatically. Although too many to list they included the Technology and Culture Forum events, the God & Computers Lecture Series, and the Civil and Environmental Colloquium 200 Series.

After over thirty years producing high-quality video courses and publishing two books, CAES has phased out the program as of January 1, 2000. Videotape masters and all rights reverted to the faculty author or were transferred to the MIT Archives and MIT Museum. Publishing rights for *Out of the Crisis*, and *The New Economics* reverted to the W. Edwards Deming Institute. MIT Press will publish soft copy editions of both books in Fall 2000. CAES retains the copyright and distributions rights to the Deming videotape series CAES produced on the same subject.

PROGRESS ACHIEVED AGAINST GOALS

Highlights of the previous section indicate that CAES has been quite successful at accomplishing desired milestones during the past year.

One of the major goals of CAES continues to be the integration of each of the operating units with one another. This year, the creation of EMCC makes such integration even more significant. We envision the boundaries between it and the other units of CAES as porous, with staff from one unit involved at various times in working groups with other CAES staff. The matrix-organization approach continues to be successful. Some specific examples include the following:

PBS Business Channel courses involve staff from EMCC, CECI, SMCS and MVP.
The PIVoT project and the Ford Masters' Voices project are managed from within CECI, but the project funding was obtained from CAES-wide efforts and the project staff is drawn from EMCC, CECI, SMCS and MVP.
The distance learning production and faculty support for the SMA program involve coordinated efforts from staff at EMCC, CECI, SMCS and MVP.

Another major goal discussed in last year's report is enhancing our capabilities in educational evaluation. Towards this end, CECI has a visiting scholar, Prof. Judy Dori, from Technion University, visiting for two years. Her expertise is in the evaluation of science teaching innovations, particularly those using new technologies. CECI is also involved in the search in the Dean of Undergraduate Education's office for a senior staff member in educational evaluation who would be an Associate Director of the Teaching and Learning Laboratory.

One of the major goals of CAES when it was redesigned in September 1995 was to engage students in our work. In 1995, there were no students engaged in research, production or thesis work. In 2000, we can report a far different story as shown in the following table.

Table 1. Student Activity

#	Student Type
2	High School Interns
27	Undergraduates
9	Graduate Student On-Line Tutors
6	Graduate Research Assistants
6	Northeastern University Cooperative Students

During the previous three years, as reported in earlier Reports to the President, CAES worked with PBS/The Business Channel to deliver video-rich professional programs leading to a certificate. On July 1, 1999 PBS/The Business Channel was sold to the National Technological University Corporation (NTUC) and the program was renamed The Business and Technology Network. NTUC is the leading provider of advanced technical education and training from a distance. An accredited, degree-granting university, NTUC offers a wide range of for-credit and professional development courses delivered via leading-edge telecommunications technologies from a working alliance of universities. MIT is one of the alliance universities. The programming schedule has also expanded to include repeat programs that cycle continuously throughout the calendar year. The project has reached a steady state of production this year.

FUTURE PLANS

CAES plans to launch *MIT-World* next year. *MIT-World* is a unique effort for a university to reach its alumni though the Internet. It will be a 24X7 streaming TV station over the Internet. The program content will be selected lectures, colloquia, seminars and special events from the MIT campus. The web-site will be password protected, only available to MIT alumni and the on-campus MIT community. Supporting corporate sponsors (we will be seeking five) will benefit by allowing up to 200 of their employees access to *MIT-World.*

MIT Video Productions will continue to play a leadership role in the design and coordination of "Level 5" technology-equipped classrooms, and rooms established to support distance learning. A significant space renovation will occur late next year on the fourth floor of Building 9 to support the MVP central control room supporting all of MIT's newly equipped distance learning classrooms.

The third degree track for SMA, Innovation in Manufacturing Systems and Technology (IMST), will begin in July 2000. Construction of a state-of-the-art central control room in Bldg. 9 and renovation of 1-390 is underway and will be operational for the Fall 2000 term.

The Technology-Enabled Active Learning (TEAL) project, focusing on shifting 8.02 from lecture/recitation format to a more active learning, studio style pedagogy, represents a major step in this direction. This project will be have significant funding per year for at least the next two years.

The MIT Council on Educational Technology has recommended that MIT develop plans for a larger research unit in the area of educational technology. Prof. Lerman, a member of the Council, will lead a planning group to look at possible options for such a unit. CECI may well be the nucleus for this type of group.

During the coming months, the PIVoT team will take measures to ensure that the software infrastructure supporting PIVoT is generic so that it can be easily adapted for video and text content from any subject. The next funded implementation of the PIVoT technology is the Ford Motor Company Masters' Voices project sponsored by the Ford-MIT Collaboration. The centerpiece of this web-based tutor will be videotaped interviews with senior brake system engineers at Ford, in which we will attempt to elicit and capture their unique experiences and craft knowledge learned over many years. The goal of the Masters' Voices web-tutor is to help preempt costly brake system design and manufacturing errors by imparting the master engineers' valuable knowledge to younger engineers, distributed via Ford's intranet.

Opportunities for the creation of other web-based video tutors have developed with two other MIT courses: Linear Algebra (18.06), taught by Prof. Gilbert Strang, and Circuits and Electronics (6.002), to be taught by Prof. Paul Gray. Last year's funding from the Lord Foundation allowed us to videotape all of Prof. Strang's 18.06 lectures given in the Fall 1999 semester. They were immediately put onto a web page for student access, and with future funding they could become the foundation of a web-based tutor similar to PIVOT. Prof. Gray will be teaching 6.002 this coming year, and new Lord Foundation funds will allow him to prepare his lecture materials this year in anticipation of videotaping the lectures the following academic year (2001-2002), in order to create the beginning of a web-based tutor for 6.002.

EMCC will provide one or more application platforms that are capable of meeting the production demands for web-based educational technologies. We will complete the first phase of the School of Engineering web-site and begin preparations for later phases of this project. We will also continue to provide support for our other current projects, even as we provide more support to the I-Campus projects.

PBS/NTUC will develop a new set of certificate-based professional development programs for calendar year 2001.

Following the model of the Ford/CAES program, Masters' Voices, CAES will seek additional corporate R&D sponsors to further its leading edge technology development in streaming media and video tutors. We hope to sign up at least two new corporate sponsors for this effort during the next year.

Just before the close of the year, General Motor's Tech Ed Program (TEP) advised ASP that our proposal to offer a distance learning course in System Dynamics (in addition to the Welding & Joining course) was accepted. The acceptance of the Systems Dynamics course via video streaming represents a milestone in TEP's strategy vis-à-vis bringing quality education to GM employees. ASP hopes to launch an Affiliates Program in the next academic year.

PERSONNEL CHANGES

Dr. J. Murray, a Senior Research Scientist at CECI, left MIT to take a senior faculty position at Georgia Tech. We added a staff support position to CECI to provide assistance to CECI's Director, Professor S. Lerman who is in the middle of a two-year term as Chair of the MIT faculty. M.Bessette will join CECI's staff this summer working full-time on the TEAL/8.02 project, primarily focusing on the creating of animations illustrating basic concepts in electricity and magnetism and on the development of "hands-on" experiments for the studio-style classes. S. Bjornestad, a doctoral candidate at the University of Bergen, has been a visiting scholar at CECI this year. Prof. J. Heines, a faculty member at the University of Lowell, spent a sabbatical year involved in CECI activities (as well as broader activities in CAES).

The EMCC formed last year and has added a number of personnel to the team either through hiring or transfer from other departments. M. Barker comes from Information Systems to manage the center. N. Sonwalkar comes from the Hypermedia Teaching Facility to provide instructional design and pedagogical integrity to the center. G. Willman comes from Information Systems to support faculty on the SMA project, joining P. Hess who was hired from Brandeis University for that project. B. Bermack has been hired to act as lead developer in the application platform work. C. D. Burrus has been hired to act as system administrator for the team. B. Brophy transferred to EMCC as an administrative assistant. We also have several personnel on assignment to the EMCC from Academic Computing, including C. Counterman and K. Livingston-Vale, for their background and knowledge of instructional design. We have also been provided with financial analysis by Academic Computing resources, first from M. Brown and most recently by W. Fitzgerald. We are also hiring, currently looking for an instructional designer, senior web-developer, graphics designer, another faculty support person for SMA, and an administrative assistant.

A fulltime program assistant, C. Sardo, has been assigned to the PBS/NTUC project. She was integral to the execution of our video course program exit strategy before joining PBS/NTUC full time.

In the administrative area, M. Cerny shifted functional areas to support our External Relations Manager.

TRIBUTES AND SPECIAL EVENTS

Richard Larson presented "Learning and Life" at MIT Technology Day.

AWARDS, PUBLICATIONS, PRESENTATIONS (EXCLUDING THOSE AT MIT)

Publications include the following:

- Y.J. Dori and R.T. Tal. (2000). Formal and Informal Collaborative Projects: Engaging in Industry with Environmental Awareness. *Science Education*, 84, 1, 95-113.
- "How Much Is 10 Percent Worth?" by Michael D. Barker, PMP, and John M. Nevison, PMP, PM Network, April 2000, pp. 61-66.

Richard Larson participated in numerous presentations in the area of technology-enabled education: US House Committee on Science, "Technology-Enabled Education and the Internet. Distance Learning and the Research University"; Buckingham, Browne and Nichols, "Professional Day Keynote", MIT Alumni Club of Colorado, Indiana Teaching of Management Science Conference, National Science Foundation, "Where are we going? The Brave New World and its Pitfalls"; Association Internationale des Etudiants en Science Economiques et Commerciales In Vienna, Austria, "Technology-Enabled Education. What is it and Where is it Going?"

In the areas of operations research he presented at: INFORMS Conference, "A Probabilistic Inventory/Routing Problem Heuristic" with Berman and Jolliffe; and Vanderbilt University, "Frontiers in Services."

Nishikant Sonwalkar presented at the following: "New Pedagogical Models for Teachers Training", at the Massachusetts Computer Using Educators' conference; presented with A. Kovgan, and R. J. Wiggins;" A

Comparative Evaluation of Desktop Learning Modalities: Desktop Learning in the 21st Century and Beyond" in the Proceedings of International Conference on Technology Supported Learning Meeting Place of the International Telelearning Industry; "Distance Learning: The Killer Application for the Internet Economy" at TiECON-Atlantic'99 and "Entrepreneurship@Internet Speed" and "New Methods of Course Delivery" presented at the Syllabus Conference and Workshop in Boston. He was a Judge in the Department of Defense Shootout on Learning Management Technologies.

More information about this center can be found on the World Wide Web at http://www-caes.mit.edu/.

Richard C. Larson

CENTER FOR EDUCATIONAL COMPUTING INITIATIVES

The mission of the Center for Educational Computing Initiatives (CECI) is to advance the state-of-the-art and state-of-the-practice uses of computation and communication technologies for learning and teaching. CECI is the research and advanced development unit of the Center for Advanced Educational Services.

CECI undertakes research and development in the application of computing and communication technologies, directed toward the goal of improving the effectiveness and productivity of learning and teaching.

Implicit in this mission statement is that new technologies can improve the quality of education in many areas and that a sustained research focus on the uses of technology will, over time, yield major improvements in how people learn. An interdepartmental, MIT-wide center such as CECI is essential because this type of research does not fit well within traditional departmental organizational structures.

CECI undertakes research that:

- Explores new technologies of relevance to learning and teaching;
- Creates new educational applications of technology; and
- Studies the effectiveness of technology and applications in improving learning

HIGHLIGHTS

Professor Steven Lerman and Dr. V. Judson Harward offered a course on the Java Revolution for PBS The Business and Technology Network. This course was delivered synchronously via satellite and asynchronously by Internet-based, streaming digital video.

CECI is the home for two of the current Microsoft I-Campus initiatives. The first, headed by Prof. Peter Donaldson, focuses on the use of Microsoft Research's prototype of video commenting software in the teaching of Shakespeare. The second project, directed by Prof. John Belcher, will completely revise the teaching of 8.02. This second initiative is also supported by the d'Arbeloff Fund and the School of Science.

CECI staff members continue to be deeply involved in the educational technology aspects of the Singapore-MIT Alliance. We are working with the EMCC to develop the Internet-based software platform for all the SMA courses. We have also been evaluating proprietary software systems for Internet course delivery and examining tools for automatic segmentation and tagging of video.

The Physics Video Tutor project (PIVOT) involves staff across CAES but is housed and managed within CECI. This project is nearing its completion. It was used extensively the past year in 8.01 and will continue to be a core resource in that subject for the foreseeable future.

PROGRESS ACHIEVED AGAINST GOALS

One of the major goals of CECI continues to be the integration of our activities with those in the rest of CAES. This year, the creation of EMCC makes such integration even more significant. We envision the boundaries between CECI and the other units of CAES as porous, with staff from our unit involved at various times in working groups with other CAES staff. The approach continues to be successful. Some specific examples include the following:

The PBS Business Channel course taught by CECI personnel involves staff from EMCC and MIT Video.
The PIVOT project is managed from within CECI, but the project funding was obtained from CAES-wide efforts and the project staff is drawn from several CAES units.

CECI staff members are working with EMCC and other CAES staff on supporting the Singapore-MIT Alliance program. Most of our work is in the area of developing new software and evaluating products for use by SMA. Various CECI projects are making use of CAES video digitizing services.

Another major goal discussed in last year's report is enhancing our capabilities in educational evaluation. Towards this end, we have a visiting scholar, Professor Judy Dori, from Technion University visiting CECI for two years. Her expertise is in the evaluation of science teaching innovations, particularly those using new technologies. CECI is also involved in the search in the Dean of Undergraduate Education's office for a senior staff member in educational evaluation who would be an Associate Director of the Teaching and Learning Laboratory.

A third goal was the development of major, large-scale projects. The TEAL project, focusing on shifting 8.02 from lecture/recitation format to a more active learning, studio style pedagogy, represents a major step in this direction. This project will be over $1 million per year for at least the next two years.

FUTURE PLANS

One of the major issues for CECI is its role in the Institute. The MIT Council on Educational Technology has recommended that MIT develop plans for a larger research unit in the area of educational technology. Professor Lerman, a member of the Council, will lead a planning group to look at possible options for such a unit. Clearly, CECI may well be the nucleus for this type of group. One of the central issues will be the mix of internally and externally focused research appropriate for such a unit.

We continue to have a strong interest in expanding our ability to conduct state-of-the-art evaluations of educational innovations involving new technologies. While Professor Dori has significantly improved our ability to do research in this area, she will leave at the end of the next academic year to return to her faculty position at Technion University. We hope that at least one full-time research staff member will be added to CECI by that time.

Finally, we believe that the long term stability of CECI's funding would be enhanced by the addition of at least one more large-scale project. This would reduce the year-to-year fluctuations of research support.

PERSONNEL CHANGES

Dr. Janet Murray, a Senior Research Scientist at CECI, left MIT to take a senior faculty position at Georgia Tech. Her expertise in the area of interactive design and her close ties to the School of Humanities has left a considerable gap in CECI's staff.

We added a staff support position to CECI to provide assistance to CECI's Director, Professor Steven Lerman. He is in the middle of a two year term as Chair of the MIT Faculty, and we expect that role will require additional administrative support that cannot be provided by the current staff.

Mr. Mark Bessette will join CECI's staff this summer. He will work full-time on the TEAL/8.02 project, primarily focusing on the creating of animations illustrating basic concepts in electricity and magnetism and on the development of "hands-on" experiments for the studio-style classes.

Ms. Solveig Bjornestad, a doctoral candidate at the University of Bergen, has been a visiting scholar at CECI this year.

Professor Jessie Heines, a faculty member at the University of Lowell, spent a sabbatical year involved in CECI activities (as well as broader activities in CAES). He has broad interests in software development and distance education, and provided advice to several of our ongoing projects.

AWARDS, PUBLICATIONS, PRESENTATIONS

Y.J. Dori and R.T. Tal. (2000). Formal and Informal Collaborative Projects: Engaging in Industry with Environmental Awareness. *Science Education*, 84, 1, 95-113.

N. Barnea and Y.J. Dori. (2000). Computerized Molecular Modeling the New Technology for Enhancing Model Perception among Chemistry Educators and Learners. *Chemistry Education: Research and Practice in Europe*, 1, 1, 109-120. http://www.uoi.gr/conf_sem/cerapie/pdf/16barneaf.pdf.

R.T. Tal, Y.J. Dori and R. Lazarowitz. (2000). A Project-Based Alternative Assessment System. *Studies in Educational Evaluation*, 26, 2, 171-191.

Y.J. Dori and M. Barak (2000). Computerized Molecular Modeling: Enhancing Meaningful Chemistry Learning. International Conference of the Learning Sciences - ICLS 2000, The University of Michigan, Ann Arbor, MI USA, 185-192.

Lerman, Steven R., Recent Innovations in Educational Technology at MIT, presentation to the MIT Club of Norway, April 25, 2000.

Lerman, Steven R., Multimedia Educational Research at MIT, invited presentation at the University of Bergen, Norway, April 27, 2000.

M. Cerny and J. Heines, SMA Student Survey, technical report, May, 2000.

Zbib, R., Harward, V.J. and DeLong, K.R., Distributed Triggers, Proceedings of the Fourth Annual Conference of the Army Research Laboratory Federated Labs Program, March, 2000.

Richard C. Larson

CENTER FOR ARCHAEOLOGICAL MATERIALS/ CENTER FOR MATERIALS RESEARCH IN ARCHAEOLOGY AND ETHNOLOGY

The mission of the Center for Materials Research in Archaeology and Ethnology (CMRAE), a consortium of eight Boston-area educational and cultural institutions, is to advance our understanding of prehistoric and non-industrial culture through analysis of the structure and properties of materials associated with human activity. Plant and animal food remains, human skeletal material, as well as metal, ceramic, stone, bone, and fiber artifacts are the objects of study, along with the environments within which these materials were produced and used. At the Center for Archaeological Materials (CAM) at MIT, investigators concentrate on the materials processing technologies that transform natural materials into cultural objects.

At MIT, CAM is administered by the Department of Materials Science and Engineering (DMSE). DMSE established a new, undergraduate major in Archaeology and Materials, Course III-C, as well as an interdisciplinary doctoral degree program in Archaeological Materials. Both sets of curricula were reviewed by the appropriate MIT committees during the 1997–1998 academic year and were in place in 1998–1999. These are the only academic degree programs of their kind in the United States.

Archaeological Science, the CMRAE/CAM undergraduate subject introduced during the 1995–1996 academic year, and offered jointly by DMSE and the Chemistry Department, continues to enjoy high popularity among students from CMRAE institutions. Ninety-two students enrolled: 73 from MIT, five from Boston University, five from Brandeis University, three from Harvard University, one from the University of Massachusetts, and five from Wellesley College; nine faculty members from four CMRAE institutions lectured in the subject.

Professor Dorothy Hosler received a fieldwork research grant from the Wenner-Gren Foundation for Archaeological Research to continue her survey and excavations at metal smelting sites she discovered in the Balsas River region, West Mexico. These are the first metal processing sites ever to have been identified in Mesoamerica. Professor Hosler continued her groundbreaking research into the earliest (ca. 1600 B.C.) ancient Mesoamerican processing technology for altering the properties of natural latex to produce rubber.

Professor Heather Lechtman received a grant from the H. Steinberg group in support of her work, with Thomas Tartaron and Edward V. Sayre, on the copper fasteners used on the hull of the USS Constitution. This project, aimed to establish the material from which Paul Revere and others made the fasteners and the methods by which they were fabricated, has been supported by the United States Navy.

Thomas Tartaron, who has served as CMRAE Graduate Laboratory Supervisor for the past five years, leaves the Center to assume the position of Assistant Professor of Archaeology at Yale University. Tartaron oversaw the move of the center's facilities from Building 20 to the new, fully renovated quarters on the fifth floor of Building 16. He helped design the CMRAE computation laboratory and co-taught graduate subjects in ceramics and metallurgy.

More information about this center can be found on the World Wide Web at http://web.mit.edu/cmrae/cmrae_home.htm

Heather Lechtman

COUNCIL ON PRIMARY AND SECONDARY EDUCATION

The Council on Primary and Secondary Education (CPSE) develops programs that bring the strengths of MIT to bear on the American K–12 educational system. The projects sponsored by the Council include the MIT/Wellesley Teacher Education Program, Teacher Sabbaticals, and MIT's Educational Outreach Programs Directory. The Council's Chairman is also involved in a number of K–12 educational efforts, including the Science and Engineering Program for Teachers and its product, the New England Science Teachers, as well as a collaboration with the Association of American Universities (AAU).

MIT/WELLESLEY TEACHER EDUCATION PROGRAM

To foster the growth of a cadre of new teachers who meet MIT's standards of excellence in science and mathematics, yet appreciate the value of different ways of approaching and understanding a problem, MIT has created a joint program with Wellesley College, the Teacher Education Program (TEP). It prepares undergraduates for Massachusetts State Certification in mathematics and science at the middle and high school levels. This program, started in the fall of 1993, has now been integrated into MIT's Department of Urban Studies and Planning. Enrollment in TEP's introductory Course 11.124 has steadily increased. During this five-year period, TEP has enrolled over 140 students in the initial course toward completing Massachusetts State Teacher Certification. Many of the students who have completed certification are now teaching in public middle or high schools, mostly in the Boston area. Others entering the program have been recruited by private, independent, schools, while some have gone on to become graduate students in schools of education such as Harvard, Stanford, University of California-Berkeley, and Columbia. Two students have entered the Peace Corps.

Undergraduates in the program must complete a major in the subject area in which they wish to teach. In addition, they must complete three courses at MIT and two at Wellesley; one of the latter is a seminar taken in conjunction with the required 150 hours of supervised practice teaching. Students must also complete 75 hours of supervised classroom observations.

The MIT Class of 1952 Educational Initiatives Fund was key to launching TEP in 1993. TEP was funded from 1994–1997 by the National Science Foundation through a collaborative called TEAMS-BC (Teacher Education Addressing Math and Science in Boston and Cambridge) which included MIT, Harvard, UMASS-Boston, Wheelock College and the Boston and Cambridge school systems. TEP is supervised by Professor Jeanne Bamberger. During the past academic year, Professor Eric Klopfer was hired to a new tenure track position in the Department of Urban Studies and Planning with the vision that he would succeed Professor Jeanne Bamberger as Director. Dr. Klopfer has a B.S. in Biology from Cornell and a Ph.D. from the University of Wisconsin. He has taught full time in the Amherst Regional High School and prior to his MIT appointment served as a Lecturer in the School of Education at the University of Massachusetts. He has studied the impact of computer systems on student learning in science, math and language arts. His current research focuses on the use of educational technology in science education and he is particularly interested in computer simulation as a tool in science education. More information about TEP can be found on the World Wide Web at http://web.mit.edu/teacher-ed/www/.

TEACHER SABBATICALS

The Class of 1952 Educational Initiatives Fund also launched the MIT Teacher Fellows Program, which brings middle and high school teachers together with MIT faculty. Not only is this program effective in helping teachers develop new and creative ways to teach math and science, it allows MIT faculty to share their expertise in the development of K–12 math and science curricula.

Three high school teachers were on campus for year-long sabbaticals. They are Mr. Dana Dunnan of Masconomet High School (Topsfield, MA); Mr. Ken Brody of Boston Technical High School; and Ms. Lynda Beck of Philips Exeter Academy of Exeter, NH. Although the '52 fund contributed to the stipends of teachers in the past, the above teachers were self-supporting. Ms. Beck and Mr. Brody will return to MIT in AY00-01 and will be joined by Isabel Courtney of the Greenwich, Connecticut school system.

Mr. Brody continues to serve as the Secretary of the New England Science Teachers (NEST). Additionally, he arranged tours of MIT by NEST teachers and students. We are pleased to have precollege educators with us. Their

understanding of the needs of classroom teachers is essential to the development of MIT's agenda in K–12 education.

EDUCATIONAL OUTREACH DIRECTORY

The Council's *MIT's Educational Outreach Programs* has been widely circulated. Approximately 65 programs are listed; programs are either conducted on MIT's campus or have the involvement of a person from MIT's faculty, staff, or student body. The directory is now also available through the Council's home page on the World Wide Web. Activities range from the Chemistry Magic Show, a 45-minute long road show of attention-getting chemistry experiments along with a running commentary, to the Voyage of the MIMI, an interdisciplinary, multimedia math and science presentation geared toward 4th-8th graders using connected educational television, software, and other instruction materials.

PROGRAMS BY THE CPSE CHAIRMAN

AAU: Since October of 1997, CPSE Chair Latanision has led a Task Force on K–16 Education, an arm of the AAU President's Committee on Undergraduate Education. The Task Force is leading an AAU-wide Implementation Plan that includes action that will accomplish the following:

- to establish on each AAU campus a Teacher Education Program that certifies disciplinary majors to teach at the precollege level and enriches the professional development of in-service teachers;
- to establish an AAU Clearinghouse on Assessment Systems to analyze emerging state assessment systems in order to determine the possible utility of the data from such systems for admissions and placement purposes; and
- to provide feedback to states on the relationship between these assessments and AAU universities' admission requirements; to lead a national conversation including university faculty, administrators, K–12 representatives and others in order to:
  - develop a clear statement of what research universities believe are the key knowledge and skills prospective students need, not only for college admissions but for a reflective and fulfilling life, and
  - identify and develop as part of the national conversation a consensus on the educational research issues that AAU institutions should address. These issues might include, for example, research to identify the best use of educational technology in the teaching and learning enterprise.

The Clearinghouse is being developed with a $2.4 million grant from the Pew Charitable Trusts, which began in April 2000.

Science and Engineering Program for Teachers: Professor Latanision directs the Science and Engineering Program for Teachers, which shares the Council's goal of science literacy for all students. Key to a good education is an enthusiastic, knowledgeable teacher. Since 1989, this program has endeavored to give educators a unique perspective of how the basic sciences, mathematics, and engineering are integrated to meet the technological challenges and needs of commerce and society. In 2000, the program ran from 25 June–1 July and had 61 participants from across the United States and four countries. Once again, this program was offered on a fee-bearing basis. Every participant covered his/her own expenses. One-third of the participants were fully supported (travel, room and board) by MIT Alumni Clubs, testimony to the concern of MIT Alumni for precollege education. For the first time, fifteen NEST teachers participated in the Star Logo Community of Learners Workshop aimed at developing useful, curriculum supporting modeling tools. The workshop was led by Professor Klopfer.

The alumni of this program, now totaling approximately 600 people, become members of the New England Science Teachers (NEST). This year, NEST members came to MIT's campus on June 30th for a two-day meeting to assess the program and determine future directions for the organization. The Annual Fall Retreat of NEST was held in Wachusett Valley, MA on 11–12 November 1999.

Given the changing demographics of the membership in NEST from a New England base to a more national and international base, the NEST management team proposed and the membership agreed to change the name of NEST to Network of Educators in Science and Technology.

We are very pleased to report that MIT alumnus, Johan von der Goltz has pledged a gift of $350,000 over a five-year period to sustain the Science and Engineering Program for Teachers and NEST.

More information about NEST can be found on the World Wide Web at http://web.mit.edu/nest/www/.

Professor Latanision has continued his service to the Commonwealth by accepting membership in two statewide organizations: the Mathematics and Sciences Advisory Council and the Science and Technology Curriculum Frameworks Review Panel.

More information about the Council can be found on the World Wide Web at http:// web.mit.edu/cpse/www/.

R.M. Latanision

OFFICE OF EDUCATIONAL OPPORTUNITY PROGRAMS

The Office of Educational Opportunity Programs was created in January of 1992 to organizationally locate the MIT/Wellesley Upward Bound Program, the MIT Educational Talent Search Program (ceased operation in fiscal year 1998), and all future programming serving low-income community youth. MIT has operated the Upward Bound Program since 1966 and began operation of the Educational Talent Search Program in September of 1991.

Upward Bound and Educational Talent Search are two of six US Department of Education: Special Programs for Students From Disadvantaged Backgrounds (TRIO Programs) created under the Higher Education Act of 1965.

The goal of these Programs is to provide college admission and preparatory information, academic support, advising, career information, and college and career exploration opportunities to the economically and/or educationally disadvantaged youth of Cambridge and Somerville.

To a large extent, the development of both Programs was influenced by the research done by psychologist Kurt Lewin and his associates. Lewin's hypothesis was that ego growth and academic performance were closely related. Moreover, he concluded that a developing ego needs to experience success in a warm and personal, structured environment for greatest development, in both a personal and social sense. Lastly, it was determined that this personal and social growth could be achieved through intervention outside of the institutions of family and school. Educational Talent Search and Upward Bound, through their year-round academic support and advising, represent just such interventions.

MIT/WELLESLEY UPWARD BOUND

The MIT/Wellesley Upward Bound Program is a year-round, co-educational, racially and culturally diverse, college preparatory program for high school youth who reside or attend school in Cambridge. Currently in its 33rd year, the Program serves 70 academically promising young men and women from disadvantaged backgrounds. The goal of Upward Bound is twofold: to motivate client high school youth such that they persist on to post-secondary education; and, at the same time, to provide them with the fundamental skills necessary for success at the collegiate level.

The following is an overview of the Program's operational phases:

The six-week summer program, conducted in residence at Wellesley College, is designed to provide the participants with a rigorous academic experience. Classes are taught by experienced high school teachers, and graduate and undergraduate students from MIT, Wellesley College and other local colleges and universities. Each participant is required to enroll in a Mathematics course, an English course and an elective course (Social Studies, Science or Foreign Language). Additionally, due to an agreement with the Cambridge Public Schools, students may receive summer school credit for up to two failed major courses taken during the preceding school year.

The academic year program, located at MIT, plays an equally important role in the educational development of participants. Building upon the motivation and enthusiasm developed during the summer, the academic year program is designed to assist and support the participant while in school. To accomplish this task, the following programs, staffed primarily by MIT and Wellesley College students (We continually strive to maintain MIT and Wellesley College students' participation through our continued involvement as a pre-practicum site for the Wellesley College Teacher Certification Program and through various outreach efforts.) when appropriate, have been developed.

The Upward Bound office is open for study, on a drop-in basis, four days a week. Tutors are available to assist participants with homework problems in addition to meeting individuals and/or small groups for specific content area tutorials.

The Program offers workshops monthly to address more specialized participant needs (e.g., SAT Preparation, Computers, Study Skills Development, Time Management, Job Readiness Skills, etc.).

Also, in an effort to help participants cope with the myriad of problems; academic, social, family, etc., the Program offers support in the areas of guidance, college, career and personal adjustment. The college advising component includes campus visits to many of the local colleges and universities and attendance at two local college fairs, while the career advising component offers exposure to career options through our Speaker Series Program as well as through research on the internet.

Lastly, the Program provides numerous field trips that have as their purpose, the intellectual, social and cultural development of the participants. Such trips included; the Museum of Science, the Omni Theater, theater productions, arcade, skiing, bowling, and roller-skating.

Eighty-seven percent of the Program's graduating seniors (Class of 2000) have enrolled in the following institutions; Art Institute of Boston, Bunker Hill Community College, Emmanuel College, Fitchburg State College, Massachusetts College of Art, Mount Ida College, Penn State, Pine Manor College, Tufts University, University of Massachusetts at Boston, University of Southern California and Virginia State University.

Ronald S. Crichlow, Evette M. Layne

CHANCELLOR

The Chancellor's office was reinstituted by the President on August 1, 1998. In recreating the office, the President transferred a number of responsibilities from the Office of the Provost to the Office of the Chancellor. These include broad oversight for graduate and undergraduate education, student life, research policy, strategic planning, campus development, and the management of the Institute's large-scale institutional partnerships.

Planning for implementation of President Vest's decision to house all freshmen on campus continues. The Residential System Steering Committee (RSSC), chaired by William Hecht, Executive Vice President of the MIT Alumni Association, submitted its final report to the Chancellor in the fall. A group of student leaders submitted a counter proposal to the Chancellor entitled *Unified Proposal for the MIT Residence System.* Based upon the input received from both the RSSC as well as the student report, the Chancellor issued a final report on the redesign of the residence system (available on the web at http://web.mit.edu/residence/systemdesign/). The Chancellor's report incorporated the best ideas from both the RSSC and the student report. The Chancellor presented this report at a public forum in early December. The Chancellor appointed Dean Kirk Kolenbrander to take responsibility for implementation of the plan described in the Chancellor's report.

Planning for the new undergraduate residence continued throughout the academic year. Steven Holl Architects completed a design for the new residence which has been recognized by Progressive Architecture with a prestigious PA Design Award. The City of Cambridge issued the necessary approvals for construction of the new residence. However, construction has been delayed pending appeal of these approvals by an abutter to the site. Given that the start of construction has been delayed by this appeal, President Vest announced that the decision to house all freshmen on campus would be similarly delayed until additional dormitory capacity becomes available. This is anticipated to occur in the fall of 2002.

The tight Cambridge and Boston housing market has made it difficult for MIT graduate students to locate suitable housing in proximity to campus. In some cases, the tightness of the housing market is making it difficult for the Institute to attract the very best graduate students. Accordingly, the Institute initiated two projects this year to provide additional housing for graduate students. A warehouse on Albany Street, adjacent to the Edgerton House, is being converted to 120 units of loft-style graduate housing. This new residence will incorporate a housemaster suite and additional amenities for the occupants. It is intended primarily for single graduate students. It is expected to open in the fall of 2001.

In addition, a larger graduate residence is being planned for the corner of Sidney and Pacific Streets, adjacent to University Park. This residence is expected to provide housing for between 600 and 700 graduate students. It will also include a housemaster suite, community space and some ground floor retail facilities. It is intended for both single and married graduate students. It is expected to open in the fall of 2002.

This past year, Dean Rosalind Williams announced that she intended to return to full-time teaching and research after five years of service as Dean of Students and Undergraduate Education. Dean Williams has had a profound effect on student life and learning at the Institute. During her tenure, the Institute's writing requirement was overhauled and replaced by a new communications requirement, orientation was completely restructured, five new pre-orientation programs were instituted for freshmen, funding for student activities was dramatically increased, the residence system was completely restructured, a plan for renovating classrooms throughout the Institute was initiated, major capital improvements were made to both the residence system and to our athletic facilities, and a large series of educational experiments were launched, underwritten by a major gift from Alex and Brit d'Arbeloff. Few deans in the history of MIT have had as large an impact on the life of our students. The Institute owes an enormous debt of gratitude to Dean Williams for her service and that of her colleague, Dean Margaret Bates, who also announced her retirement this year as Dean of Students.

Prompted by the resignation of Dean Williams and the retirement of Dean Bates, the Chancellor instituted a modest reorganization of Office of the Dean of Students and Undergraduate Education. Under the previous structure, the Dean of Students reported to the Dean of Students and Undergraduate Education, who reported to the Chancellor. As a result of this structure, the Dean of Students and Undergraduate Education often found that her time was dominated by crises arising in the student life area. Consequently, it was difficult to focus on issues of curriculum development, educational reform, and pedagogy. Accordingly, the Chancellor reorganized the offices so that the

newly named Dean for Student Life will report directly to the Chancellor, in parallel with the Dean for Undergraduate Education. The Dean for Student Life was also made a member of Academic Council, thus giving further voice to student life issues at the highest levels of the Institute. As part of this reorganization, the offices of Residential Life and Student Life Programs; Athletics, Physical Education and Recreation; Counseling and Support Services; Campus Activities Complex; and the MIT Card Office will report to the Dean for Student Life. The offices of Academic Services, Admissions, Career Services and Preprofessional Advising, Student Financial Services, Minority Education, and Student Services Information Technology will report to the Dean for Undergraduate Education. In addition, the offices of both the Dean for Student Life and Dean for Undergraduate Education were relocated to the Infinite Corridor to promote greater access to students.

This past year MIT entered into a major partnership with Cambridge University. This partnership will support joint research, joint curriculum development, joint teaching, and student and faculty exchanges. It is designed to create a new form of academic enterprise, bringing together two of the world's great universities. The formation of this partnership was announced by the Chancellor of the Exchequer of Great Britain in November at a press conference attended by President Vest and the Vice Chancellor of Cambridge University, Sir Alec Broers. The partnership formally came into being upon the signing of incorporation documents in early summer. It is formally known as the Cambridge-MIT Institute. The Chancellor coordinated MIT's role in the negotiations leading to the creation of the Cambridge-MIT Institute. Professor Daniel Roos played a major and instrumental role in helping to establish this partnership. Professor John Vander Sande will be the MIT Executive Director of the Cambridge-MIT Institute. The British government and UK industry are providing $135 million in funding over five years to support the partnership.

The Committee on Resources for Space Planning, chaired by the Chancellor, spent $24 million to renovate classrooms, lab space, and office space on campus. Major projects funded this year include renovations for the Department of Materials Science and Engineering, the Center for Technology Policy and Industrial Development, the Center for Learning and Memory, the Astrophysics section of the Department of Physics, and renovations to library space in Building 14. In addition, Music and Theater Arts was relocated to renovated space in Buildings 4 and 10, thus freeing up additional space for expansion of Humanities in Building 14. Additional investments were made to upgrade space in the student life area, including a new indoor and outdoor track for Athletics and an expansion of the 24-hour coffeehouse in the Student Center. Through resources made available by the Department of Facilities, the Institute is continuing its program of upgrading the life safety systems in the undergraduate residences. The new process for prioritizing space change requests instituted last year appears to be operating smoothly.

Last year the Chancellor, together with the Dean for Research, created a Research Council consisting of the Directors of a number of major labs and centers. The Council provides guidance and advice to the Chancellor and the Dean for Research on a variety of issues related to research funding and administration. This year the Council began discussions about potential changes by which the Institute supports research administration in departments, labs, and centers.

The Chancellor co-chairs the Council on the Environment with Professor David Marks. The Council coordinates Institute-wide environmental education and research. This past year the Institute hosted the Annual Meeting for the Alliance for Global Sustainability, a collaboration between MIT, the University of Tokyo, and the Swiss Federal Institute of Technology. The Council also administers the Martin Family Society of Fellows and the Wallenberg Fellows Program.

The Chancellor coordinated the Institute's reaccreditation review of the New England Association of Schools & Colleges. The review was organized largely around the Institute's response to the Report of the Task Force on Student Life and Learning. The Institute was reaccredited for another ten years as a result of this review. The report of the accreditation team and the Institute's response can be found at http://web.mit.edu/accreditation. The Institute's report provides a detailed description of our progress to date in responding to the recommendations of the Report of the Task Force on Student Life and Learning.

Lawrence S. Bacow

ASSOCIATE PROVOST

The mission of the Office of the Associate Provost is to assist the Provost and other academic officers in carrying out academic and program support functions. The Office of the Associate Provost worked on the following activities in the past year.

Investigation Guide
Besides handling a number of grievances and providing assistance to others in conducting investigations, the associate provost worked with a group from the Ombuds Office, Human Resources, the Dean's Office, and others to develop a guidebook for conducting investigations at MIT. The guidebook aims to increase the quality, thoroughness, and fairness of investigations. The completed guide will be published and posted on the web.

Child Care at MIT
The associate provost chaired a faculty and staff committee exploring issues related to the development of a child care center in the Stata Building. The child care center in the Stata Building represents a substantial commitment to child care and to achieving the goal of 150 additional on-campus day care slots. The tentative plan for the Stata Center calls for more than a hundred slots including significantly, slots for infants. While a separate committee is exploring issues of design, this staff committee is exploring issues of governance, programming, and other issues. The committee held focus groups, conducted a community survey, and will issue its recommendations in the fall of 2000.

Implementation of the Faculty Vote on ROTC
The faculty vote and the charge from the President require that we undertake activities in four areas. The four areas include: MIT's involvement in national advocacy; efforts to create opportunities for students irrespective of sexual orientation to participate in on-campus activities centered on leadership; initiatives to improve the campus climate for gay and lesbian students; and a reinsurance program to guard against financial losses to students who might suffer an involuntary disenrollment from ROTC because of sexual orientation. The summary of activities in the four areas is as follows:

With respect to national advocacy there has been no substantial engagement by peer institutions. There does not appear to be any prospect that the more relevant restrictions of the Solomon Amendment will get a serious review in this Congress. Our monitoring of the legislative arena will continue, and we will follow up on the DOD secretary's committee inquiry into alleged harassment.

Our leadership development effort in the past year was to support a new course centered on leadership development that would engage the cadets and noncadets as well as professors of military science supported by regular faculty. The course (Leadership and Management/15.328) went well. Thirty-five students took the course. However, almost all who took the course were cadets. Course leaders are committed to greater outreach in the coming year. These should not be problems in the coming year. It is impossible to be precise regarding whether there has been a change in the campus climate. There are no reliable data or metrics. There were no cases and no action in this area in 1999–2000.

Phillip L. Clay

INTERNATIONAL SCHOLARS OFFICE

The International Scholars Office (ISO) enables MIT faculty and staff to bring international researchers and professors to campus for a variety of purposes. The ISO advises on immigration matters, issues visa documents, and provides guidance, workshops, information booklets and flyers on a wide range of issues relevant to the international scholar population. Weekly orientations are held for incoming scholars and family members. The ISO also engages in advocacy efforts to protect international educational exchange, prevent burdensome regulations, and clarify and improve related regulations and procedures. The ISO is very fortunate to receive oversight from the Associate Provost, with additional assistance from Charlene Placido, Assistant Dean for Research.

PRIMARY ACTIVITIES
The ISO served a total of 1464 international scholars who were affiliated with MIT during the period July 1, 1999 to June 30, 2000, up from 1369 last year; the ISO also served these scholars' accompanying family members. International scholars are key to the vitality and global scope of MIT's teaching and research efforts. MIT is among the United States institutions hosting the most foreign scholars, ranking seventh nationally. MIT scholars come from 81 countries, with Japan, Germany and People's Republic of China in the lead, consistent with national trends. In the past year, the ISO worked closely with administrators in 67 departments, laboratories and centers, and prepared

the appropriate visa documents or petitions for incoming and continuing scholars and their families. In order to prepare such applications and appropriately advise international scholars and their hosts, ISO staff members maintain an intricate knowledge of ever-changing immigration laws and regulations and coordinate MIT's needs, the scholar's unique qualifications and visa history, and regulatory realities. During the 1999-2000 period, 980 scholars were sponsored under MIT's J-1 exchange visitor program and 185 were sponsored by MIT on the H-1B visa, as compared with 916 on MIT's J-1 and 148 on MIT's H-1B sponsorship last year; the rest of the scholar population had other sponsors or nonimmigrant categories. The ISO also submitted 12 permanent residence petitions to the Immigration and Naturalization Service (INS) on behalf of MIT faculty members and upper-level researchers, while advising numerous others at various stages of a multi-step process now taking over two years from start to finish.

In addition to advising and providing extensive web-based and written information for international scholars and their families, the ISO sponsored periodic workshops for MIT administrators responsible for international scholars. Such workshops have been required more frequently given staff turnover at the Institute. The International Scholars Office also offered its popular annual tax workshop for international scholars in February, and co-sponsored the fall International Open House for newcomers with the International Students Office. Staff members are also active at professional conferences, with each staff member presenting this year at conferences held by NAFSA: Association of International Educators. This spring the office underwent a computer transition from the Macintosh to the PC environment in order to update hardware and software and accommodate immigration software needs. This upgrade would not have been possible without the generous assistance of Theresa Regan, Director of the Office of Computing Practice, and the oversight of the Sharon Ralston in the ISO, who bears responsibility for computer matters in addition to her primary advising duties.

CHALLENGES AND ADVOCACY EFFORTS

A number of institutional and global trends have a direct bearing on the work of the International Scholars Office. These include the proliferation of new partnerships between MIT and industry and the growth of new programs and international collaborations. Taking just the first example, industry and academic partnerships, immigration regulations do not readily lend themselves to dual or multiple affiliations. There has been a steady increase in the number of MIT scholars requesting J-1 off-campus work permission or concurrent H-1B petitions from the ISO, and a similar increase in scholars with outside visa sponsorship seeking accommodation of concurrent affiliations at MIT. The ISO is striving to keep up with these and other challenges.

The ISO is also proactive in the legislative and regulatory arena, coordinating with the Associate Provost and the Director of the MIT Washington office in advocacy efforts. The ISO Director and Assistant Director serve on NAFSA: Association of International Educators working groups, and the Director has continued membership in the Consortium on Higher Education Immigration Issues as well as the American Association of Universities Immigration Advisory Group. She also served the last of her three-year term as moderator at the annual meeting of the Ivy League Institutions Plus Three group, held this year at MIT. The International Scholars Office and International Students Office served as co-hosts and made all the arrangements, and the Associate Provost gave the welcoming remarks.

The Immigration and Naturalization Service continues to develop a national system known as "CIPRIS" by which international offices will eventually be required to electronically track and report information on international students and scholars to INS. MIT joined the successful national campaign to combat a controversial INS plan mandated by Congress. The proposal called for schools to act as collection agents for a fee to be paid by foreign students and J scholars to fund the tracking program. The ISO also celebrated the fiftieth anniversary of its J-1 program for exchange visitors, and continued efforts to influence national J-1 policies and procedures to the benefit of MIT. Nationally, the J Exchange Visitor Program is undergoing profound changes as it adjusts to its new home in the Department of State. The ISO Director participated in the Department of State's review of the Exchange Visitor Program office, and was told that these contributions were key to the final report. The H-1B visa continues to be problematic. Although the temporary increase in the annual allotment of H-1B petition approvals available to new H-1B beneficiaries is still in effect, the quota remains inadequate. For the third year in a row, the "cap" was reached in the spring, rendering the H-1B visa option for some scholars impossible until October. Penny Rosser and Ivana Hrga-Griggs have once again been extremely proactive and have worked closely with departments to prevent or minimize disruption of MIT teaching and research efforts. The higher education community continues to pursue an academic exemption from the cap or a separate allotment of H-1B numbers.

PERSONNEL

Dana Bresee Keeth continues to serve as Director and Penny Rosser as Assistant Director. The three Advisors to International Scholars continue in their positions: Jennifer Stephens, part-time, Ivana Hrga-Griggs, who enjoyed a two-month maternity leave following the birth of her baby in May, and Sharon Ralston, who completed her first

year with the ISO. Sirijit Lertkhachonsuk (Sandy Lo), Administrative Assistant, left to pursue international travel, and the ISO welcomed Michael Welch to this position in January.

More information about the International Scholars Office may be found on the World Wide Web at http://web.mit.edu/scholars/.

Dana Bresee Keeth

ASSOCIATE PROVOST FOR THE ARTS

The focus of the Office of the Associate Provost for the Arts during 1999–2000 has been on the further development and planning for new resources for the arts, greater national engagement in arts initiatives and a new focus on MIT's relationship to K-12 education; the development and sustenance of the expanding arts community.

RESOURCES AND PROGRAMS

The prospect for much-needed educational facilities for Music and Theater Arts took two major steps forward. Arrangements to relocate the faculty and administrative offices from 14N to Buildings 4 and 10 became final. Planning moved forward for the development of a Laboratory for the Performing Arts on the lower level of E15.

In response to a matching grant from Council for the Arts member, Ron Cordover, the MIT Museum developed designs for a new façade for Building N51 and received permission to move the Museum store to street level with an entrance on Massachusetts Avenue.

Fiscal year 2000 also saw the arrival of Jane Farver, the new director for the List Visual Arts Center. Over the year Ms. Farver brought in Bill Arning, the new curator; David Freilach, the new administrative officer and John Rexine Jr., the new fine arts registrar.

Through the work of consultant Patricia Fuller and Jane Farver, the MIT Percent for the Arts policy became clarified and operative, with Ms. Farver sitting as a member of the Campus Planning Steering Committee. Artists Matthew Ritchie and Dan Graham were engaged to create pieces for the new Athletic Center and the new undergraduate dormitory.

The long awaited signage for the List Visual Arts Center went up on Ames Street. In addition, banners recognizing MIT arts programs were hung on the Medical Center Plaza.

NATIONAL ENGAGEMENT AND K–12

The Associate Provost for the Arts participated in a number of initiatives involving K–12 education. In cooperation with Paul Parravano, co-director of the Office of Government and Community Relations, the Associate Provost began planning for the MIT chapter of Teachers as Scholars (TAS), an ongoing series of seminars from all five schools for K–12 teachers. The Associate Provost was also invited to be on the TAS Board of Advisors.

The Associate Provost and Paul Parravano hosted the regional meeting of the Woodrow Wilson Foundation's Schools and Scholars Program at MIT in January 2000. The Associate Provost also joined Mr. Parravano and Ron Latanision at the National Schools and Scholars Conference in Washington, DC later that spring.

The MIT Museum hosted the first of a series of dinners including representatives of all the MIT K–12 programs in order to begin to develop a coordinated effort.

In addition, the Harvard School of Education Arts Program invited the Associate Provost to join the co-directors of the recently funded project for profiling local schools with active arts programs.

The MIT Museum and the List Visual Arts Center initiated vigorous outreach programs, particularly in relation to K–12.

The Associate Provost served his first year as the MIT representative on the Board of Trustees of the MFA.

In collaboration with the Business Committee for the Arts, the Associate Provost and Neal Hartman of the Sloan School of Management continued planning sessions for Creative Visions, a series of national think tanks exploring the intersection of business, education and the arts.

Florida International University invited the Associate Provost to serve as consultant to its programs in the arts.

THE ARTS COMMUNITY

At the request of the Rosalind Williams, Dean of Students and Undergraduate Education, the Associate Provost served as an active member of the Founders Group for the new undergraduate dormitory.

At the request of Philip Khoury, Dean of the School of Humanities and Social Sciences (SHSS), the Associate Provost joined the Committee on Women's Issues in SHSS.

Fiscal year 2000 also saw the renaming of SHSS to the School of Humanities, Arts and Social Sciences.

Assistant Professor of Theater, Thomas DeFrantz, hosted the first annual Conference on Black Performance. He also collaborated with Associate Professor of Theater Brenda Cotto-Escalera, on the performance piece, *Monk's Moods*. Associate Professor Janet Sonenberg officially assumed the position of Head of Theater Arts.

ACHIEVEMENTS AND HONORS

Institute Professor John Harbison's opera, *The Great Gatsby*, opened at the Metropolitan Opera House in New York in January of 2000.

Professor Anita Desai's new novel, *Feasting, Fasting*, was a major publishing event of the year.

Jane Farver was one of the five curators of this year's Whitney Biennial.

Alan Brody's play, *Matchpoint*, was chosen as one of five finalists for the Summer Futurefest in Dayton, Ohio.

The MIT Symphony, under the baton of Assistant Professor Dante Anzolini, toured Europe in the spring of 2000, performing in Brno, Prague, Budapest and Vienna.

Alan Brody

LIST VISUAL ARTS CENTER

The MIT List Visual Arts Center's (LVAC) mission is to present the most challenging, forward-thinking, and lasting expressions of modern and contemporary art to the MIT community and general public in order to broaden the scope and depth of cultural experiences available on campus. The LVAC's mission also is to reflect and support the diversity of the MIT community through the presentation of diverse cultural expressions. This is accomplished through four avenues: changing exhibitions of contemporary art in all media by the most advanced visual artists working today that take place in the LVAC galleries (E15); the Permanent Collection of art (comprising large outdoor sculptures, artworks sited in offices and departments throughout campus, as well as art commissioned under MIT's Percent-for-Art policy which allocates funds from new building construction or renovation for art; the Student Loan Art Program, a collection of fine art prints, photos and other multiples, maintained solely for loan to MIT students during the course of the academic year; and interpretive programs to offer the MIT community and the public various perspectives about LVAC changing exhibitions and MIT's art collections.

HIGHLIGHTS OF THE YEAR

- Increased attendance for 1999–2000 exhibitions by 55%. This is the highest attendance since 1994, when actual attendance counts replaced estimated figures.
- Provided gallery tours of exhibitions to 68 groups. (An increase of 54 visits over previous year).
- Revised the Percent-for-Art Policy. It is now called the *Art on Campus Policy* and was endorsed by the Academic Council.
- Wrote a Collections Management Policy that was endorsed by the Advisory Council in April 2000.
- For conservation reasons, re-sited Alexander Calder's *Intermediate Model for the Grand Sail* to the lobby of the Wiesner Building (E15) from the plaza at Building 9; and Jean Ipousteguy's *Cenotaph* to an area near the Bush Building from Compton Court.
- Worked with Facilities and Planning Departments and the Sloan School on the reconstruction of the plaza of the Sloan School and refurbishing of Bernar Venet's *Two Indeterminate Lines* to be returned to the plaza July 2000.
- Worked with Facilities and Planning Departments and the Media Lab to come to an agreement with Richard Fleischner to commission him to make adjustments in collaboration with Fumihiko Maki, architect of the addition to the Media Lab to the plaza Fleischner designed for the Wiesner Building.

- Deaccessioned Michael Steiner's *Niagara* due to condition problems inherent in the work, and returned it to the artist.
- Worked with Facilities and Planning Departments to re-site and conserve Beverly Pepper's *Trinity*.
- Worked with client groups and architects Roche & Dinkeloo, and Sasaki to commission artist Matthew Ritchie to create a new work for the Central Athletic Facility.
- Worked with Founder's Group and architect Stephen Holl to commission artist Dan Graham to create a new work for a new student residence.
- Worked with Risk Management Officer J.L. Keith and Vice President J. Curry to develop a standardized contract for artists' projects for percent-for-art program.
- Received $15,000 grant from Massachusetts Cultural Council as part of a multi-year grant for general operating support. Also received grants and donations from the Council for the Arts, and numerous individuals.
- During annual MIT Council for the Arts meeting, hosted gallery exhibition tour for Council members.
- During the 1999–2000 season, made loans of approximately 200 artworks to various departments and individuals across MIT campus.
- Participated in Freshman Arts Program Orientation and Campus Preview weekend programs, providing tours and receptions.
- Under the sponsorship of the Council for the Arts, initiated first collaborative program with the MIT Visual Arts program for artist Mel Chin to meet with visual arts students in conjunction with his exhibition at the LVAC in March 2000.
- Re-instituted the List Essay Prize for writing on contemporary art, which was won by junior Carl Steinbach.
- Held six artists' talks on campus by locally and internationally recognized artists attended by approximately 600 people.
- Provided training for 12 interns from MIT, Harvard, Wellesley, Rhode Island School of Design (RISD), Tufts, Massachusetts College of Art, Colby College, and other schools.
- Received 36 positive critical reviews for exhibitions, including positive reviews in The New York Times, The Boston Globe, The Boston Herald, The Harvard Crimson, Art on Paper, Art New England, New Art Examiner, Arts Media, and ArtNews.
- Purchased 13 new works to add to the Student Loan Art Program, six of which will be exhibited in the Stratton Student Center during the 2000–2001 academic year, and then cycled into the lending collection in the fall of 2001. The other works will be available to students in the fall of 2000.

EXHIBITIONS

Student Loan Art Exhibition (LVAC galleries, September 8–September 28, 1999). Annual exhibition of 350 works comprising Student Loan Art Collection. MIT Students may view displayed works, and then enter a lottery to be awarded the work of their choice on loan for the academic year and hang in their dormitory, apartment or office.

A Unique American Vision: Paintings by Gregory Gillespie (Hayden and Bakalar Galleries, October 9, 1999–January 2, 2000, curator Donald Keyes and guest curator Carl Belz). A retrospective of works by a well-known Massachusetts figurative painter. Organized by the Georgia Museum of Art.

María Magdalena Campos Pons (Reference Gallery, October 9, 1999–January 2, 2000, curator: Jennifer Riddell). Multi-media exhibition by Boston artist Campos Pons, featuring glass objects made at the Urban Glass Workshop in New York and video projections. Catalogue with essays by Riddell and Michael Harris.

Jane and Louise Wilson: Stasi City and Crawl Space. (Hayden Gallery, January 2–April 9, 2000, guest curator: Lelia Amalfitano.) Video installations by artist twins nominated for the Tate Museum in London's 1999 Turner Prize.

Lilla LoCurto and Bill Outcault: selfportrait.map. (Reference Gallery, January 28–April 9, 2000, curator: Helaine Posner.) Digital photographs based on full body scans manipulated through a mapping software program by Brooklyn-based artist pair. Catalogue published in collaboration with Lyman Allyn Museum, featuring essays by Posner and David Gelertner. Exhibition is travelling to: Selby Gallery, Ringling School of Art and Design, Sarasota, FL; Hatton Gallery, Colorado State University, Fort Collins, CO; California State University, Long Beach, CA; Lyman Allyn Museum of Art at Connecticut College, New London, CT; Mary and Leigh Block Museum of Art, Northwestern University, Evanston, IL; Fort Wayne Museum of Art, Fort Wayne, IN; Bellevue Art Museum, Bellevue, WA.

Knowmad—Map: Motion+Action=Place (Bakalar Gallery, February 3–April 9, 2000, curator Jane Farver). Installation featuring video game and projections based on "mappings" in rugs by nomadic cultures in the Middle East and Central Asia. Created by a confederacy led by artist Mel Chin, and including Rocco Basile, Emile Busse, Tom Hambleton, Brett Hawkins, Andrew Lunstad, Chris Parrish-Taylor, Osla Thomason Kuster. Originally created for the Weisman Museum in Minneapolis.

Film and Video from the 2000 Whitney Biennial (Bartos Theater, April 21–23, 2000) Three-day festival of screening of works that were concurrently on view at the Whitney Museum of Art in New York.

Experiments in the Everyday: Allan Kaprow and Robert Watts: Events, Objects, Documents. (Hayden and Bakalar Galleries, April 27–July 2, 2000; curators: Dr. Benjamin Buchloh and Dr. Judith Rodenback, organized by Columbia University). Exhibition of works by Watts and Kaprow who were both students of Meyer Shapiro, and who both taught at Rutgers University. Includes a survey of works by Fluxus participant Watts and early "Happenings" by Kaprow.

Luca Buvoli—Flying: Practical Training for Beginners (Reference Gallery, April 27–July 2, 2000, curator: Jane Farver.) Installation featuring the premiere showing of an animated and live-action film by New York based artist Buvoli. Also featured drawings and sculptures used to make the film, and an artist's book published in cooperation with Edizione Corraini in Italy. Exhibition travels to Austin Museum of Fine Arts in December 2000.

INTERPRETIVE PROGRAM HIGHLIGHTS

LVAC curatorial staff led 10 private gallery tours during the course of the exhibition year for MIT and 60 for groups including 12 visits from the Museum School, seven from Mass Art, five from RISD, four from the Art Institute of Boston, four from UMass, Boston, two from the Cambridge Center for Adult Education, and others for groups ranging from the Pasadena Friends of Contemporary Art to the Alexander Dreyfuss School of Arts in West Palm Beach, FL. Other groups came from New York, Connecticut, and various Massachusetts locations.

Exhibition artist Gregory Gillespie and curator Carl Belz engaged in public dialogue in the gallery about Gillespie's retrospective exhibition.

Artist María Magdalena Campos Pons delivered a well-attended gallery talk on the occasion of her LVAC exhibition.

Artists LoCurto and Outcault and curator Helaine Posner held a public conversation in Bartos Theater in conjunction with the artists' exhibition.

Artists Jane and Louise Wilson delivered a public lecture on their work in Rm 10-250. This was co-sponsored by the Graduate School of Design at Harvard.

Artist Mel Chin delivered a public lecture on his work in Rm 10-250.

Artist Luca Buvoli delivered a public lecture on his work in the Medical Building auditorium.

Staff conducted an IAP seminar, "Conceiving and Designing a Contemporary Art Exhibition" for the fourth year running, attracting a group of 12 MIT and Wellesley participants.

COLLECTIONS

There were four gifts of art to the permanent collection including works by Terry Winters, George Condo, Helen Frankenthaler, and Rikrit Tirivanija. Donors included Vera G. List, Donald and Jeanne Stanton and Kim Sooja.

The Student Loan Art Program attracted 916 MIT students to the LVAC gallery over the 17-day period of the exhibition of artworks. A total of 600 students submitted entries to the lottery to borrow artwork and approximately 300 works were disbursed.

FUTURE GOALS

Continue to increase audience both from MIT campus and from Boston area.

Hire a part-time educator and increase cross-disciplinary use of LVAC's exhibitions, programs, and facilities.

Undertake a conservation survey of permanent collection sculpture on campus through an Institute of Museum and Library Services Conservation Assessment Program grant received by LVAC.

Label artworks across campus.

Initiate first collaboration with Cambridge Public Schools. In fall of 2000, LVAC will offer a yearlong after-school program for students at Cambridge Rindge and Latin High School.

STAFF NEWS

Jane Farver joined the LVAC staff as director in July 1999. Patricia Fuller joined the LVAC staff as consultant for the percent-for-art program. David Freilach joined the LVAC staff as administrative/development officer in September 1999. Magdalena Fernandez, returned to her position as gallery attendant in September 1999. Kimberly Nyce, administrative assistant, left the staff in September 1999. Jill Aszling left the LVAC staff in March 2000. John Rexine joined the LVAC staff as registrar in April 2000. Bill Arning joined the LVAC staff in April 2000. Jon Roll left the LVAC staff in June 2000.

ADVISORY BOARD CHANGES

Blake Brasher joined the LVAC Advisory Board Committee as a student representative. Michael Coden, Jerry Friedman, Jenny Frutchy, Marian Merril, and A.G. Rosen joined the LVAC Advisory Board Committee. Peter Temin has left the LVAC Advisory Board Committee for one year and will re-join the committee in 2001. Martin Rosen left the LVAC Advisory Board Committee.

More information can be found about the MIT List Visual Arts Center at http://web.mit.edu/lvac/www/.

Jane Farver

MIT MUSEUM

The MIT Museum exists to document, interpret and communicate to a diverse audience, the activities and achievements of the Massachusetts Institute of Technology and the worldwide impact of its innovation, particularly in the fields of science and technology; and to enhance the spirit of community inside the Institute through the promotion of dialogue both at MIT and between the Institute and the wider world.

The major theme for the Museum's activities this year has been planning:

- Planning for the future. The staff and the Advisory Board have set a new direction for the Museum, in support of our new mission, with a five-year strategic plan.
- Planning for development of our physical plant. After successfully raising $250,000 as a match to a $250,000 pledge from an alumnus and friend of the Museum, the façade project will be completed in fiscal year 2001. This major renovation project will give us a new building façade, a new entrance for all our visitors, a first floor store, a new reception area, and one-third more exhibition and programming space. A bold architectural transformation, it promises to put the Museum firmly on the map.
- Planning with our audience. An important step for the Museum has been the integration of audience research into our exhibition and program planning. This integration is essential if the Museum is to serve our diverse visitors effectively. Surveys and in-depth visitor interviews are just two of the tools we are using in this endeavor.
- Planning for collection development. The Museum has begun a major deaccessioning program to enable us to refine, develop and expand the collections in line with our new mission. With limited space and resources, coupled with our goal to collect objects "significant" in the life of MIT, we must make carefully considered decisions to remove items from the collections. This program will continue over the next few years.

The Museum served 37,902 visitors this year, an increase of 15% over last year's total admission figures. This increase is extremely encouraging as it shows that even without a major new exhibition the Museum has maintained the gains of last year (31%) and continued to attract more visitors.

COLLECTIONS

Two new members joined the Collections Committee this year: Professor Nicholas Patrikalakis from Ocean Engineering (OE) and Dr. Jack Coleman, visiting scientist at the Plasma Science and Fusion Center. Professor Doug Carmichael resigned at the end of his three-year term. The Committee met five times and considered nineteen acquisitions of which twelve were accepted into the permanent collection. The Museum began a major deaccessioning program with the transfer of the Arnott model railroad to Wenham Museum. Large numbers of excess copies of The Tech, Technique and Technology Review have been passed onto other MIT departments, including The Tech offices, MIT Libraries and Black Alumni/ae of MIT (BAMIT). Also publications were offered to alumni/ae over Tech weekend in early June and many alumni/ae were delighted to obtain a copy of their yearbook. Much of the Committee's time was taken up with these and other deaccessioning and disposition decisions.

The Provost allocated funds to support the enhancement of collections storage on the second and basement floors as part of our preparation for our American Association of Museums (AAM) reaccredidation visit in 2001. All but one of our storerooms in the Metropolitan Warehouse have now been emptied and the material stored onsite. There were thirteen loans in total from the collections including several to institutions outside the US.

Architecture and Design Collections

Use of the Architecture and Design Collections has increased again this year, with 101 telephone inquiries, 98 email and written requests, and 23 researchers using the Collections on site. An important acquisition was three architectural models from Professor Maurice Smith. Drawings from The Architects Collaborative collection were loaned to the Addison Gallery of American Art in Andover, MA and the Museum Folkwang in Germany.

The highlight of the year was the opening of the exhibition *Dreams in Brick and Mortar: Alvar Aalto, MIT and the Design of Baker House*, from September 30 to January 28 in the Museum's Compton Gallery. This exhibition of drawings, photographs, documents and furniture examined not only the construction of Baker House dormitory but also the important moment in MIT's history when it was created. Support for the exhibition came from the Council for the Arts at MIT, Harry Ellenzweig of Ellenzweig Associates, Harvey Steinberg '54 and Perry Dean Rogers and partners. The related educational programming served over 350 people.

For the launch of MIT's Capital Campaign, we organized a series of panels outlining the development (from architect selection and program development, through fundraising) of MIT's Stata Center. Entitled *Frank O. Gehry and the Design of MIT's Stata Center*, the exhibition was also on view at the Wolk Gallery and at Kresge Auditorium for Tech Weekend.

Two grants were obtained for cataloging the collections this year. The Graham Foundation for Advanced Studies in the Visual Arts is supporting initial cataloging of The Architects Collaborative collection and we received an Institute of Museum and Library Services Conservation Project grant for the collections of Marjorie Pierce '22 and Professor Richard Filipowski.

Hart Nautical Collections

Activity in the Hart collections this year was comparable to previous years. Inquiry levels remained high with about 1,000 inquiries received via phone, fax, email and mail. These inquiries generated over $12K in total sales from the Hart Nautical Collections ($6K in plan and photo sales, $3K in fees and royalties and $3K in wholesale sales of guides to the Herreshoff and Davis-Hand collections).

The George Owen 1894 Collection project was completed last August. Funding is being sought to publish a guide to this collection. The *Reliance* model project was completed in October with the unveiling of the new model by the donors, Mr. and Mrs. John Dema, at a reception at the Hart Nautical Gallery. The model of this 1903 Herreshoff America's Cup winner was commissioned by the Demas for Hart in 1995, and is valued at $65K.

A new IAP boat building program was organized by the Hart in January. A 12-foot wooden sailboat designed by MIT alumnus Joel White '54, was built in the Department of Architecture's woodshop in the first two weeks of IAP 2000. Students and staff worked together to build the boat under supervision of a professional boat builder. The boat is now part of the MIT Nautical Association's fleet and may be sailed by any member. The project was funded by the Deans of Architecture and Engineering, Department of Ocean Engineering, the Edgerton Center, John Lednicky '44, the MIT Museum and the IAP office.

At the end of 1999 John Lednicky '44 again made a gift to benefit the Hart Nautical Collections. The Lednicky fund was used to help fund a case for the *Reliance* model, the IAP class mentioned above and to contribute to printing the guide to the George Owen Collection. Other contributors to printing the Owen guide are as follows: David Wadleigh '38, Halsey Herreshoff '60, Richard Berry '32, John Worton '48, Evan Polley and Chris Morrison.

MIT students under Professor Patrikalakis (Ocean Engineering) used plans from Hart for a group design project in the Spring 2000 semester.

Holography Collections

In February we hired Steve Maloney, a graduate from Simmons College, as a part-time assistant to complete a documentation project funded by the Shearwater Foundation, the Museum and MIT President Chuck Vest. Steve has a graduate degree in Archives Management, including courses in Photographic Archives and Database Management. Prior to working at the Museum he spent nine months working for WGBH-TV, Boston, cataloging and preserving video recordings and associated materials, and several months working at the Rhode Island School of Design's photographic archives. To date the collection database has been updated and expanded and 30% of the holograms are inventoried and fully cataloged. All catalog data has been verified. In addition the archives have been organized, with finding aids ready to be placed on the Museum's web site. This project is an essential prelude to further development of this collection.

There were two loans from the collection to galleries in Copenhagen and Finland.

Memorabilia And Photograph Collections

The Historical Photograph collection continued to receive heavy use, with over 300 inquiries and 150 visitors from within and without MIT. Over 100 requests for photographic material were fulfilled. Some notable MIT projects included material for the Millennium Ball, the Museum and Archives new timeline in Building 10, alumni seeking material for reunions and the Alumni Association's use of images for a multi-media presentation at the Great Court Gala on Tech Day. Inquiries came from organizations as diverse as PBS, Boeing, the Sierra Club and the Chemical Heritage Foundation. We continued to digitize images, working with MIT Video Productions, on an as-needed basis.

Science And Technology Collections

In this first year that these collections have had a dedicated curator much was accomplished. Over 100 inquiries were answered about artifacts and related archival materials, including assistance with two television documentary programs for the History Channel and WGBH's *The American Experience* and photographers and authors from *National Geographic*. The curator also assisted the Lincoln Laboratory and the Department of Aeronautics and Astronautics with their special exhibitions, giving advice on planning, design and the selection of artifacts.

There were several accessions this year, most notably a group of historical computing artifacts from the Compaq Computer Corporation. These 65 items comprised three sets of artifacts representing the Whirlwind, SAGE and LINC projects at MIT. They were originally part of the DEC corporate collections. The Museum had, before this acquisition, extremely limited material from these research programs and these pieces are extremely important additions to our collections. After a six-week preservation project, the Memory Test Computer from the Whirlwind program was put on display in the reception area of the Museum.

Approximately 50 MIT students used the collections for their work, including in-museum seminars for three undergraduate classes and one freshman seminar. The curator also lectured to another Science, Technology and Society (STS) class of 50 students. Most notably two UROP projects were done on the collections; one student worked on the Whirlwind artifacts and the second is carrying out research in anticipation of "An MIT Education" (working title) exhibition. Research and planning has now begun for this exhibition, which will focus on the MIT educational experience since the founding of the Institute.

EDUCATION AND OUTREACH

The Museum's monthly family program series, *Family Adventures in Science and Technology (F.A.S.T.)*, and the *Friday After Thanksgiving (F.A.T.) Science Chain Reaction* with Arthur Ganson continued to attract substantial media attention and record numbers of enthusiastic visitors to the Museum during the fall and winter months. This year, hands-on *F.A.S.T.* programs were co-developed and generously staffed with students, faculty, and researchers from Electrical Engineering, Mechanical Engineering, Materials Science, Aeronautics and Astronautics, The

Edgerton Center, and Haystack Observatory. Together *F.A.S.T.* and *F.A.T.* programs provided high-quality, MIT-centered science and technology experiences to over 4,000 members of the visiting public, preschool to adult, drawn from throughout the greater New England region.

The Museum's popular school and group programs served over 3,500 students throughout the state and greater New England. Many MIT students continued to help lead these programs, contributing greatly to their success. The Museum's school and group programs have fostered an increase in the diversity of the museum's audience by successfully extending its reach into communities traditionally underserved by museums. These include those from rural areas, special needs youth and adults, and urban minority youth (which now make up over 40% of our group audiences).

The Museum expanded partnerships with school districts and individual schools in Cambridge, Somerville, and Greater Boston. For example, collaborating with Cambridge Public Schools, the MIT Museum co-coordinated a Massachusetts Department of Education Content Institute for public school teachers, *The Design Process: Light, Color, and Energy,* from June 1999 to May 2000. In January, the Museum piloted a Middle School physics program, *Gears and Gizmos,* again in partnership with Cambridge Public Schools, using the Museum's *Gestural Engineering* exhibit and staffed with MIT student IAP Fellows. In April we began a new school partnership with the Haggerty Elementary School in Cambridge, following the model of our successful partnership with the West Somerville Neighborhood School.

EXHIBITIONS

The Museum has embarked on a three-year plan to revise, refurbish and expand its exhibition offerings in support of the Museum's new mission and focus on MIT endeavor and discovery. In order to better understand and serve our audience, we have also developed and begun implementation of a long-term plan to integrate audience research and evaluation into planning of exhibitions. Surveys and visitor interviews are being used to help improve visitor satisfaction with exhibitions and attract new and larger audiences. The Exhibitions and Public Programs Committee of the Board met twice to consider exhibition proposals.

Main Facility

In October 1999, working with researchers and students from the Artificial Intelligence (AI) Laboratory at MIT, the Museum began planning for a major new exhibition and conducted visitor evaluation to help in this planning process. *Robots and Beyond: Exploring Artificial Intelligence at MIT,* due to open in late October 2000, will challenge Museum visitors to exercise their minds and imaginations as they explore innovations and cutting edge technologies developed and inspired by research from the AI Lab.

In April 2000, the Museum began preliminary planning for a new exhibition exploring the unique nature of the MIT educational experience, due to open Tech Day 2001.

Compton Gallery

The Museum installed three exhibitions in Compton Gallery: *On the Edge of the Future: Mid-Century Convocation at MIT*; *Dreams in Brick and Mortar: MIT, Alvar Aalto, and the Design of Baker House*; and *Observing the Observers: Wenyon and Gamble.* The latter was organized in collaboration with the Artists-in-Residence Program. The Museum also collaborated with the Institute Archives to produce a new timeline for the corridor cases outside the Compton Gallery – bringing the information up to the beginning of 2000.

Traveling Exhibitions

Two traveling exhibitions currently offered by the Museum continue to tour museums throughout the US: *Unfolding Light: The Evolution of Ten Holographers* and *Seeing the Unseen: Photographs by Harold Edgerton.* The Museum, in partnership with theoretical physicist, Eric Heller, also received National Science Foundation (NSF) grant funding to plan a new traveling exhibition, *Approaching Chaos,* that will debut at Compton Gallery in February 2001.

DEVELOPMENT AND MUSEUM SHOP

The Museum's fundraising efforts focused on the Façade Initiative, a major new capital project, and recurring needs in the areas of collections management and access, educational programs and exhibitions. The Façade campaign, which included a major gifts solicitation effort as well as a direct mail appeal, raised $472,165 from 50 donors. We

also secured grants from the Graham Foundation and the Institute of Museum and Library Services to process and rehouse three significant collections within the Architectural Collections and from the Ralph L. Stephens Trust to benefit our Holography Collection and Program. The T. Backer Fund and the Cambridge Public Schools (via the MA Department of Education) provided grants for family education programs and a professional development Content Institute for Massachusetts teachers. A number of individuals made gifts to support various needs and programs, notably Mrs. J. Howard Beck, for unrestricted support; John A. Lednicky '44 (OE), for the Hart Nautical Collections; and Martin E. Zimmerman '59 (Electrical Engineering), for the Architectural Collections. A total of $77,755 was raised from 31 donors, including 25 individuals, one foundation, two corporations, and three public sector funders. The Development Committee of the Advisory Board held four meetings and worked steadily to meet the fundraising goal for the Façade Initiative.

The Museum Shop operations were completely reorganized this year. The Museum is working with I/S services as the pilot site for MIT's development of an e-commerce system and we expect significant sales via this route over the next year. The Museum commissioned a report by museum store consultants MarketPlace Associates to project revenue for a new store on the first floor of the building, as well as an assessment of current retail operations. The report concluded that a store on the first floor should be very successful, and we are moving ahead to open our new ground level store in fiscal year 2001.

PERSONNEL

Several new members of staff joined the Museum this year. Jenny O'Neill became the collections assistant for the Hart Nautical collections and photographic collections at the beginning of the fiscal year. Debbie Douglas and Bob Peters began work at the beginning of August as Curator of Science and Technology and Commercial Services Manager respectively. The new Director of Exhibitions and Public Programs, Janis Sacco, started in the middle of August. Finally Ken Murphy arrived as Assistant Manager for Commercial Services in late September. Kimberly Alexander Shilland left at the end of June for a senior curatorial position at the Peabody Essex Museum in Salem, MA.

FUTURE PLANS

The Museum's five year strategic plan defines ten strategic objectives for the Museum: to increase participation of the MIT community in the Museum's activities; to improve our services to visitors; to develop new exhibitions and educational programs that effectively communicate the breadth and diversity of MIT activity; to focus on collection development and refinement; to improve documentation and preservation of collections; to collaborate with others to interpret and communicate the Institute's history; to develop the Museum's online presence; to expand and extend the reach of Museum exhibitions and educational programs to new and larger audiences; to diversify the base of the support for the Museum; and to develop the Museum's operating infrastructure to meet the needs generated by growth. The accompanying three-year implementation plan details the following key objectives for fiscal year 2001:

- Open two major exhibitions *Beyond Robots: Exploring Artificial Intelligence at MIT* and "An MIT Education" (working title).
- Complete Museum façade project including the move of the Museum store to the first floor.
- Begin development of our web site to become a 'virtual' museum
- Complete first phase of renovation and reorganization of basement storage areas.

More information about the MIT Museum can be found on the World Wide Web at http://web.mit.edu/museum/.

Jane Pickering

MUSEUM LOAN NETWORK PROGRAM

The Museum Loan Network (MLN)—the first comprehensive national collection-sharing program—stimulates, facilitates, and funds long-term loans of objects of cultural heritage among US institutions to enhance museums' "permanent" installations. Established in 1995, the MLN is funded by the John S. and James L. Knight Foundation and The Pew Charitable Trusts and is administered by MIT's Office of the Arts. The MLN concurrently addresses two pressing issues facing the national museum community. Currently, hundreds of thousands of objects of cultural heritage sit in museum storage facilities around the country, most never put on display and many not adequately catalogued. At the same time, hundreds of museums are restricted in the range and quality of permanent exhibits they

can mount because of the limitations of their own holdings. By fostering collection-sharing between museums, the MLN brings to light our nation's enormous hidden heritage in a meaningful way.

The program continues to expand its emphasis on network building, both through human and technological resources. In the Fall of 1999, the John S. and James L. Knight Foundation and The Pew Charitable Trusts renewed funding for the MLN for a second three-year period. Each foundation awarded $1,897,000 for a combined gift of $3,794,000. Not only will this support allow the MLN to continue its successful program involving the loan of objects to and from art museums, it also adds new momentum to the MLN's initiative to include a range of objects of cultural heritage previously outside its domain. To reflect these new disciplines, new members have been added to the MLN Advisory Committee, as well as to the curatorial ambassadors. The curatorial ambassadors, appointed in the fall of 1997, continue to help promote the program, assist applicants in locating potential lending partners and provide curatorial advice to MLN. The curatorial ambassadors' work has already resulted in several grant applications and heightened awareness of MLN in the curatorial community. Development continued on the MLN on-line directory, a practical means of identifying objects of cultural heritage available for long-term loan to eligible museums throughout the US, which now contains over 4,000 objects from 33 institutions. The MLN continues to develop virtual exhibitions on its homepage. Featuring projects made possible by MLN implementation grants and designed in conjunction with MIT's Educational Media Creation Center (EMCC), these virtual tours not only provide visual models for museums to understand how to creatively utilize MLN, but also stimulate public interest in the arts and provide greater access to museums' hidden permanent collections. There are now seven virtual exhibitions on the MLN homepage featuring installations from the Mobile Museum of Art, Williams College Museum of Art, Joslyn Art Museum, Mint Museum of Art, Harn Museum of Art, Los Angeles County Museum of Art, and University of Kentucky Art Museum.

The MLN continues to work with communications consultant Resnicow/Schroeder who was hired in the Fall of 1998 to lead an aggressive press initiative. The MLN has been very pleased with the long term results of the initiative so far. NBC Weekend Nightly News produced a focus segment on the MLN which aired on April 8, 2000. In addition articles on the MLN have appeared in The Chronicle of Higher Education, The Art Newspaper, ARTNews, USA Today, Arts and Antiques, The Chronicle of Philanthropy and Cybertimes. An Associated Press(AP) story that was dispatched nationally and internationally resulted in articles in over 40 newspapers including The Boston Globe, The Albany Herald and the Indianapolis Star. In October 1999, the third MLN newsletter, Museum Loan Network News 1998–1999 was printed in a run of 5,000 copies and distributed at museum conferences and by mail. This 20-page newsletter features testimonial stories by grantees, a listing and map featuring 1998–1999 grant winners and their partner institutions, and an article by one of the curatorial ambassadors concerning the permanent collection. This year the MLN has started a series of postcards of selected objects from the MLN Directory. Since February 2000, two postcards were distributed to a list of 2,000 museum professionals as well as at museum conferences. The first postcard featured a Franklin sedan from the Henry Ford Museum & Greenfield Village and the second one a Chagall painting from The Saint Louis Art Museum The intent of the postcards is to promote the MLN Directory and encourage museums to check it periodically for new additions. The MLN Director and/or Program Associates lectured about the program and related museum issues at the following annual meetings: the American Association of Museums Meeting, Baltimore; the College Art Association (CAA), New York; the combined Association of State and Local History and Mid-Atlantic Association of Museums conference, Baltimore; the New England Museum Association meeting, Worcester; the Midwest Museums Conference, Indianapolis; the Mountain Plains Museum Association meeting, Santa Fe; the Southeast Museum Association meeting, Birmingham; and the PA Federation of Museums & Historical Association meeting , State College. The MLN was also represented by a booth at most of the above mentioned conferences.

The MLN awards two types of grants to eligible nonprofit institutions in the US: planning grants and implementation grants. At the February 2000 Advisory Committee meeting held in Miami and the June 2000 meeting held at MIT, 37 grants totaling $566,840 were recommended for approval by MIT for funding to museums throughout the country. These awards will facilitate the sharing of diverse types of objects such as textiles, decorative arts, furniture, machinery, photographs, sculptures and paintings among museums of differing disciplines ranging from historical societies to natural history museums to culturally-specific institutions to art museums. Survey grants were awarded to such prestigious institutions as the University of Pennsylvania Museum of Archaeology and Anthropology, The Field Museum, and the USC Fisher Gallery. Travel grants were awarded to the Minnesota Museum of American Art, the Fort Mojave Indian Tribe Historic Preservation Program and the Museo de

Arte de Puerto Rico, among others. Implementation grants were awarded to such diverse institutions as the Alaska State Museum, the Turtle Bay Museums and Arboretum on the River, and the Indianapolis Museum of Art.

In April 2000, the MLN hosted its first in a series, of "think tanks" exploring policy issues relating to museum concerns. The first, held in Lexington, Kentucky, entitled " Museums as Catalysts for Inter-disciplinary Collaboration," brought together an auspicious group of professionals from diverse disciplines, including dancers, art historians, actors, playwrights, historians, science writers, educators, librarians, public television producers and funders. Presently the MLN is planning "think tank 2" which will take place at MIT in the fall of 2000 and coincide with the 50th Anniversary Celebration of the School of Humanities and Social Science.

Mark Wright, formerly assistant curator and researcher at the Smithsonian Institution's Center for African American History and Culture and the Anacostia Museum, was hired in September 1999 as MLN's second program associate.

Julie Barrett, administrative assistant, resigned in June 2000.

More information about the MLN can be found on the World Wide Web at http://loanet.mit.edu/.

Lori Gross

OFFICE OF THE ARTS

In the eleventh year of the Office of the Arts, Arts Communication continued to maintain and increase awareness of the arts at MIT both within and outside of the Institute by publishing and distributing up-to-date information on MIT arts events and exhibitions; actively promoting arts-related activities, programs and people at MIT; and working with the Admissions Office to inform prospective students about the arts at MIT. Significant developments included the expansion of the presence of the arts during Campus Preview Weekend; and the research, writing, design and conceptual development of a new arts brochure.

INTERNAL (MIT)

Director of Arts Communication Mary Haller worked with writer Neal Kane, designer Kathy Forsythe and MIT's Publishing Services Bureau on the development of a new MIT arts brochure, aimed at student recruitment but usable as well for fundraising and general public relations purposes. Focus groups were held with current MIT students to help determine content and tone. Seven students and four faculty members were photographed and interviewed for the profiles that make up the main content of the piece.

The LED sign in Building 16 was linked up to the Office of the Arts with help from staff in Physical Plant, Information Systems and Telecommunications. Announcements were written and programmed by Administrative Staff Assistant Lynn Heinemann and student assistant Tina Lin.

Haller and David Freilach of the List Visual Arts Center presented a one-session class during MIT's Independent Activities Period entitled, "Getting the Word Out: Publicizing Your MIT Arts Programs and Events."

Haller worked with staff from the Admissions Office and selected arts faculty and staff to enhance the presence of the arts for Campus Preview Weekend 2000 (April 6-9). In addition to the many performances and exhibitions taking place at MIT that weekend, special arts-related activities included the Lobby 7 Arts Stage, a "Music at MIT" open forum, a joint open house/dessert circuit between the MIT Museum and List Visual Arts Center, gallery tours at the List Center, an architecture lecture by Associate Professor Wellington "Duke" Reiter, numerous open courses in Music and Theater Arts, and open rehearsals by the MIT Symphony Orchestra, Wind Ensemble, and Chamber Chorus. The Lobby 7 "Arts Stage" was the site of informal performances by numerous music, theater and dance groups.

Heinemann worked with the staff of Information Systems during the development and testing of MIT's new official electronic events calendar—joining the team for consultations on policy, structure and design, while overseeing and maintaining arts listings.

Heinemann maintained and publicized the current World Wide Web site for the arts at MIT, updating calendar listings, publishing each week's Tech Talk arts stories and creating new links as required.

Arts Communication continued to oversee ArtsNet, which consists of about 90 campus arts representatives, the "Arts at MIT" bulletin board in Lobby Seven and the weekly "Arts Hotline" (253-ARTS).

Haller represented the arts as a member of the Communications Operations Group (COG) and Information Group.

STUDENT RECRUITMENT AND COMMUNICATION

For the fifth year, MIT's admission application included tear-out postcards for prospective students to use to request information on the arts at MIT and indicate specific arts interests. Postcards and email responses were received from 1,819 individuals and a copy of the *Student's Guide to the Arts* and a "freebie" flyer were sent to each with a letter from Associate Provost for the Arts Alan Brody. Students who were eventually admitted and who had indicated interests in music and in theater were sent congratulatory letters from Professor John Harbison and Associate Professor Janet Sonenberg giving specific information on opportunities in those areas at MIT.

TECH TALK COVERAGE

For the 11th year, Arts Communication provided text and images for the weekly Arts Page in Tech Talk. Material for 21 feature Arts Pages and eight Month-at-a-Glance Arts Pages were compiled and written by Heinemann, edited by Haller. Haller attended weekly News Office meetings and both she and Heinemann continued to work closely with its staff. Arts Page stories were made available on-line through the World Wide Web. Copies of the Month-at-a-Glance Arts Page (including two two-pagers) were mailed monthly to 471 individuals at their request.

Twenty-four feature arts-related stories and nine arts-related photos-with-captions were published in Tech Talk's general spaces, including three arts stories and two arts photo-captions on the front page. Activities and individuals involved in arts were cited four times in Tech Talk's "Here & There" column and five times in the "Awards & Honors" column. Heinemann was the primary writer; other contributors included Haller, members of the News Office staff and members of the MIT arts community.

SELECTED MEDIA ATTENTION

The following are some of the people and projects across the Institute who received external media attention through press releases and publicity efforts initiated by Arts Communication:

The newly-inaugurated Freshman Arts Program during Orientation Week

Council for the Arts at MIT (CAMIT)'s presentation of McDermott and Kepes Awards to Diller + Scofidio and Howard Johnson, respectively

Edward James Olmos' lectures at MIT.

Two MIT faculty artists chosen for 2000 Whitney Biennial (Dennis Adams and Krysztof Wodiczko).

Guillermo Gómez-Peña's residency and presentation of Abramowitz Memorial lecture with collaborator Roberto Sifuentes

The appointment of Jane Farver as director of the List Visual Arts Center

The appointment of Bill Arning as curator of the List Visual Arts Center

A performance by MIT's East African Music Ensemble (MITCAN) featuring Professor James Makubuya and Chinese pipa soloist Wu Man.

Cambridge First Day at MIT, which honored four Cambridge-based arts organizations.

OTHER NATIONAL ATTENTION

Artist-in-Residence Arthur Ganson was featured in a Forbes Magazine article on "The art and soul of a new machine."

National Public Radio's November 13 broadcast of "The World of Opera" featured the Houston Grand Opera's performance of *Resurrection*, written by Media Laboratory Associate Professor Tod Machover (music) and Music and Theater Arts Lecturer Laura Harrington (libretto). Preceding the broadcast, Lou Santacroce interviewed Professor Machover for the irreverent "At the Opera." The work received critical attention from publications such as Newsweek, Newsday, The New York Times, the New York Post, New York Daily News, the Washington Post, Toronto Globe and Mail and the Wall Street Journal, among others.

The premiere of *The Great Gatsby* by Institute Professor of Music John Harbison at the Metropolitan Opera received wide media attention, locally, nationally and internationally.

The Museum Loan Network, the MIT-based program that promotes collection sharing among US museums, was the subject of a feature story on NBC Nightly News on April 8. The Network is "helping institutions large and small bring America's hidden heritage out in plain sight," said NBC, which noted that "since its founding in 1995, the program has provided over $2 million in grants to 132 institutions in 42 states."

OTHER LOCAL ATTENTION

The Freshman Arts Program—a student-designed pre-Orientation program implemented this year—prompted a major feature in the Boston Globe. Headlined, "Left brain, meet the right," the article explained how this new program "puts science scholars back in touch with their creative and playful selves," while following the students to several of the more than 30 workshops "designed by MIT students, an inventive and ingenious bunch if ever there was one."

The annual Boston Phoenix "The Best" supplement (November 5) named MIT's noon hour Chapel Concerts as the "Best place to hear live music in the middle of a weekday." Praising the Eero Saarinen-designed building as "unique both visually and acoustically," the Phoenix informed readers that "a holy hour there—Thursdays at noon throughout most of the academic year—will make your day, and each concert is a different kind of treat... Or just show up any time the chapel is open and sit for a bit on the straight-backed wicker chairs to enjoy the interplay of light and silence."

MIT fared well in the Boston Globe's annual "Best of 1999" lists. Christine Temin's compilation of "Best Art" included Maria Magdalena Campos-Pons' installation *Meanwhile the Girls Were Playing* at the List Visual Arts Center (number seven on a list of ten). Richard Dyer included Institute Professor of Music John Harbison twice on his list of "Best Classical Music"—once under best new or recent works for his new opera, *The Great Gatsby*, and again as "Musician of the Year," declaring that "John Harbison stands as a model of musical citizenship."

Two MIT composers made Boston Globe columnist Richard Dyer's listing of defining moments in classical music for the Globe's end-of-the-century retrospective series on the arts. Media Laboratory Associate Professor Tod Machover's opera *Valis* was included as a defining moment of the years 1981–89 and Institute Professor John Harbison's opera, *The Great Gatsby* was recognized for 1991–99.

In other year-end accolades, the List Visual Arts Center's *Corporal Politics* scored in the Boston Herald's list of highs for the decade. The controversial 1992 exhibition, which received donations from the rock group Aerosmith and playwright Jon Robin Baitz after the National Endowment for the Arts revoked funding, included images of body parts to represent the fragmentation and alienation of individuals in society.

A Thanksgiving Day Boston Globe feature on the MIT Museum's monthly Family Adventures in Science and Technology Programs proclaimed that the MIT Museum makes science "family fun." Writer Karen Campbell also praised the appeal of the exhibitions—"As one wanders from room to room, there is a continual sense of surprise and delight at the poetry and whimsy of scientific and technological achievement."

Dramashop's *Ethnographic Museum of Irrelevant Races (EMIR)*, a temporary installation of satirical living dioramas, directed by internationally-known performance artist Guillermo Gómez-Peña, attracted the attention of Boston Globe correspondent Elijah Wald. "Gómez-Peña ...feels that the young people he is working with do not have 'the ideological and cultural certainties that our generation had,' " Mr. Wald wrote in a lengthy feature article. "On the other hand, he thinks that this has its advantages, at least for performers. They can stand between cultures, ages, political affiliations, and comment both as insiders and outsiders. Thus the spectacle of MIT students, a

privileged minority in many ways, acting out the anger, stereotypes, and confusion of their ethnic, national and socio-sexual backgrounds."

"Although [MIT] is rightly acknowledged for science and technology, what is less evident is its great contribution to the arts and humanities," begins an article in the April/May Art New England about the List Visual Arts Center's new director Jane Farver. "Significantly, [Ms. Farver] talks about responding to the needs of MIT, its brilliant faculty, staff, and student body, and to the extended Boston arts community as well," writes Charles Giuliano. Her appointment, he says, "feels refreshingly different."

An April 27 "Cyberarts Special" issue of the Boston Globe Calendar featured alumna Teresa Marrin Nakra, who received her PhD in Media Arts And Sciences in February, 2000, and Associate Professor Tod Machover. Calling MIT's Media Lab the "epicenter of the city's classical electronic music scene," Christopher Muther wrote, "Machover plays musical Willie Wonka over a fantastic array of futuristic technology. There are bottles that emit sounds when the stoppers are removed, a denim jacket sewn with a thread that plays music as you walk, and a ball stuffed with a tiny MIDI synthesizer that makes music as you squeeze it."

"When you consider that maybe one in four of MIT's students might just as well have qualified for admission to the New England Conservatory, the anecdotal correlation between music and the sciences acquires evidentiary weight," wrote Boston Globe Correspondent Michael Manning in his review of the MIT Symphony Orchestra's May 12 concert. Mr. Manning praised the orchestra's "solid musical values," conductor Dante Anzolini's "simple, unaffected direction," and noted that pianist David Deveau (soloist for Beethoven's 'Emperor' Concerto) "stressed lyricism over grandeur... [taking] pains to illuminate, even manipulate the harmonic rhythm, exposing chordal contours submerged in the texture, stressing leading tones and upbeats to gild the stately masterpiece with flecks of detail."

The Globe published an article previewing Zojeila Itzel Flores' Panamanian dance performance (Oct. 9). Ms. Flores had used her 1998 List Foundation Fellowship in the Arts for Students of Color to "make a journey of the heart into her heritage and identity," wrote Debra Cash, explaining the biology senior's summer travels to Panama to learn the native dances and the folklore behind them. Ms. Cash described the List Fellowship Program as a "remarkable program that attempts to affirm the diverse cultural identities of MIT students at the same time that it is nurturing their emergence as members of the international technical elites."

More information about the Office of the Arts can be found on the World Wide Web at http://web.mit.edu/arts/.

Mary L. Haller

COUNCIL FOR THE ARTS

The Council celebrated the new millennium by increasing its membership to a record high number; fundraising achievement followed suit with our best gift total ever, coinciding with MIT's new capital campaign.

Council Standing Committees

Annual Meeting (Dorothea Endicott, chair). The 27th Annual Meeting of the Council for the Arts at MIT took place on October 28 and 29, and was focused on Architecture. The Annual Meeting dinner was held on Thursday evening, October 28, at Le Hotel Meridien in Boston, at which the Eugene McDermott Award in the Arts was presented to the architect-artist team Elizabeth Diller and Ricardo Scofidio (See Special Programs, below). The Friday morning business meeting began with an address by Provost Bob Brown and Chancellor Lawrence Bacow. Committee reports followed and a panel discussion on the state of the School of Architecture at MIT led by MIT faculty member Wellington Reiter.

The Gyorgy Kepes Fellowship Prize was presented to President Emeritus Howard Johnson (see Special Programs, below) at the Annual Meeting luncheon on Friday, October 29.

Arts Scholars Committee (Brit d'Arbeloff, chair). This, the newest of the Council's programs continues to experience "growing pains" as members of the committee and Council staff work to create the appropriate environment for the development of a community of student artists. This year the monthly programs included a hands-on printmaking session, a try at the Gamelan, and a trip to see the Huntington Theater's production of Philip

Kan Gotanda's play, *The Sisters Matsumoto*, followed by a discussion with cast member Ryun Yu '96, the first MIT student to graduate with a degree in Theater Arts.

Communications (Pepi Weis, chair). The Communications committee produced three issues of the Council newsletter, Council Currents, this year, to great success. Council Currents is written by Council members, for Council members.

Development (Daniel Vershbow '45, chair). As of this writing (7/11/00) 72 Council members provided unrestricted contributions averaging $4,147. Nineteen non-member donors contributed unrestricted gifts averaging $1,945. The total raised for the year was $335,549.

Grants Program (Bradford M. Endicott '49, chair). The Grants Committee awarded a total of $79,595 in the form of 40 grants this year. The projects requesting funding included the very straightforward, such as the third Artist Behind the Desk Series, which features MIT staff people exhibiting their works of visual art, having recitals, poetry readings and dramatic presentations. The Committee also funded somewhat esoteric projects such as an interactive wall sculpture made entirely of the eyes and beaks from the toys known as "Furbies." This is the normal course of the Grants program, which receives such requests for support for all sorts of creative endeavors.

Membership (Bernard G. Palitz '47, chair). As of this writing, Council membership stands at 112, with six *ex officio* members and 106 regular members. The following new members have joined the ranks of the Council since last July: Michael Coden '67, Mark Epstein '63 Charles Frankel '83, Darian Hendricks '89, Rhoda Katzenstein, Christine Lamond, Emanuel Nadler '54, Andrea Nasher, Sara-Ann Sanders and Toby Sanders '90 (our first mother-daughter Council members) Michael Speciner '68 and Glenn P. Strehle '58.

Special Events Committee (Catherine N. Stratton, chair). On March 23–26, 2000, a group of 40 Council members and staff traveled to Miami, Florida for the fourth Council for the Arts at MIT Arts Excursion. Highlights included visits to the private collections of Martin Z. Margulies, Ruth and Richard Shack, and Rosa and Carlos de la Cruz. Council member Paul Gluck served as host and tour guide for the convivial group. A splendid and exhausting time was had by all.

AFFILIATED COMMITTEES

List Visual Arts Center (LVAC) Advisory Board (Kitty Glantz, chair). A new curator, Bill Arning, was hired.

MIT Museum Advisory Board (Harvey I. Steinberg '54, chair). The MIT Museum Board initiated the fundraising effort for the renovation of the façade of the MIT Museum Building, designed by Wellington Reiter.

Artist-in-Residence Committee (Stephen Memishian '70, chair). Organized along the lines of the MIT Museum and LVAC Boards described above. This committee works with MIT Office of the Arts Director of Special Programs Maureen Costello and a panel of arts professionals, Council Members and artists to bring artists to the MIT campus to work throughout the Institute.

Special Programs

Since 1980, the Council has underwritten MIT's enrollment in the University Membership Program offered by the Boston Museum of Fine Arts. This program provides free admission and discount benefits to all MIT undergraduate and graduate students, as well as ten membership cards for the daily use of MIT faculty and staff.

Sixty-two members and guests of the Council for the Arts at MIT attended the January 12, 2000 performance of MIT Institute Professor John Harbison's new opera, *The Great Gatsby* at the Metropolitan Opera House in New York City. Prior to the event, Council member Stuart Uram and his wife Lilly Langotsky held a wonderful cocktail reception in their home, complete with a breathtaking view of Manhattan from the 55th floor.

The free-ticket program with the Boston Symphony Orchestra continued this year. MIT students can obtain, with their student ID, free admittance to Thursday evening and Friday afternoon concerts on a day-of-show, stand-by basis. The success of this unique program continues unabated.

The successful Student Performing Arts Excursions Series continued, with tickets to the following events made available at no charge to MIT students: humorist-essayist David Sedaris at Sanders Theater; Chekhov's *Ivanov* and Dario Fo's *We Won't Pay! We Won't Pay!* at the American Repertory Theater; George Bernard Shaw's *Mrs. Warren's Profession* at the Huntington Theater, World Music's presentation of the Masters' *Soul of Mbira* (African thumb piano); The Boston Lyric Opera's production of Philip Glass' *Akhnaten* and the National Ballet of Mozambique.

The Gyorgy Kepes Fellowship Prize was presented by Angus MacDonald to President Emeritus Howard Johnson at the Annual Meeting luncheon on Friday, Oct. 23. Dr. Johnson most generously donated his prize money to the Council for the Arts at MIT. At the Annual Meeting dinner at Le Hotel Meridien, the Eugene McDermott Award was presented by Dorothea Endicott (McDermott Award Committee chair) and Wellington Reiter (MIT Architecture faculty member) to Diller + Scofidio, New York-based architecture team.

At the Institute Awards Convocation on May 2, Associate Provost for the Arts Alan Brody presented the Laya and Jerome B. Wiesner Student Art Awards to Sean Sutherland '00, Jason Krug '00 and Gabor Csanyi (G). The Louis Sudler Prize was presented to Thomas Cork '00 for his achievement in Theater Arts.

More information about the Council for the Arts can be found on the World Wide Web at http://web.mit.edu/arts/camit.all.html.

Susan R. Cohen

SPECIAL PROGRAMS

Special Programs began its tenth anniversary year at MIT. The diverse palette of Artist-in-Residence programs has included a wide range of artists working in departments throughout MIT over the years and an Advisory Board Sub-committee has been formed to plan a celebration of this work for Spring 2001. The scope and depth of the residencies of performance artist Guillermo Gómez-Peña in the School of Humanities and of sound and environmental artist Diane Willow in the Media Lab marked highpoints in this year's programs.

Artist-in-Residence Advisory Board

In its third year, the Advisory Board, under the leadership of chair Steve Memishian G'70, developed a five year plan, including budget projections and fundraising strategies to double the size of the Artist-in-Residence Program. The Board hopes to use the mission statement, "Goals and Strategies" developed last year as the foundation for a fundraising "viewbook." Development Officer Glenn Billingsley will be invited to the first meeting of next year to advise on further fundraising efforts.

A process of program evaluation was proposed and tested and several discussions of what is the essence of an effective program were conducted. Felice Frankel, Michael Wenyon and Susan Gamble and Diane Willow each presented their Residency work to the Board.

Memishian proposed a rotation plan to recruit new membership for the Board. This plan, which invites the current members to stay until the last meeting in 2001, will be presented in September.

School of Humanities and Social Science

In collaboration with the Theater Section, Foreign Languages and Literatures, the Comparative Media Studies Program and the Program in Women Studies, the William L. Abramowitz Program sponsored the fall residency program of performance artists Guillermo Gómez-Peña and Roberto Sifuentes. Substantial collaboration supported integrating these artists into classes, presenting a film series of their work and hosting a public discussion of their controversial approaches to performance.

Special Programs and collaborating departments also recruited support from the Dr. Martin Luther King Jr. Visiting Professor Program and the Associate Provost for the Arts for Gómez-Peña's return in January, for an Independent Activities Period (IAP) Program with Theater's Dramashop. Gómez-Peña, Assistant Professor Brenda Cotto-Escalera and invited guest, Dr. Leticia Nieto, created a new production with Dramashop students. *The Ethnographic Museum of Irrelevant Races*, a provocative multi-media performance of living dioramas, opened in February 2000.

In addition, the Theater Section and the Program in Writing and Humanistic Studies supported lecture-demonstrations with choreographer Donald Byrd; Split Britches Theater Company; Beijing Opera scholar Ghaffar Pourazar and theater artists Jola Cynkutis and Khalid Tyabji.

School of Architecture
Diane Willow, sound and environmental artist, began her first year as an Artist-in-Residence, in collaboration with Professor Mitchel Resnick of the Epistemology and Learning Group of the Media Laboratory and with Dr. Martha Gray in Health Sciences and Technology. In collaboration with MIT students, Willow created two installations in the course of the 1999–2000 school year. *The Arbor*—a bamboo construction designed to exhibit playful creations and projects made by the Epistemology and Learning Group and their guests—was installed around the entrance to the group's primary workspace for The Mindfest Conference in the Fall of 1999. *SEAt*, an interactive, double-seated, sound sculpture, delighted the MIT community in three locations on campus in late Spring and Summer 2000. Diane Willow was invited to continue in the Residency Program in 2000–01, and was invited to join the staff of the Epistemology and Learning Group.

1999 McDermott Award winners in architecture Diller and Scofidio were scheduled for a Spring residency program, but were forced to cancel due to unexpected business in Switzerland. The program is rescheduled for October 2000.

Performance Artist Ellen Zweig worked with support from the Office of Academic Computing and in collaboration with Professor Joan Jonas and Lecturer Julia Scher of the Visual Arts Program and Ed Barrett from the Program in Writing and Humanistic Studies. Zweig worked with MIT and New York University students to create a live interactive performance over Internet 2 entitled, "The Electric Travels of Lucy Anna Morel," in the Spring semester. Zweig was invited to return in the Fall of 2000 with support from the Ida Ely Rubin Fund.

School of Engineering
Kinetic sculptor Arthur Ganson worked with the Department of Mechanical Engineering with support from the Ida Ely Rubin Fund. He continued with Professor Samir Nayfeh and students in "Advanced Kinematics 27.2" along with offering well attended talks in the *Gestural Engineering* exhibition at the MIT Museum. Professor Nayfeh continued work on "The Flickering Tower."

Michael Wenyon and Susan Gamble, holography and new media artists, finished their final year at the Haystack Observatory. They were invited by Jane Pickering to mount an exhibition of the resulting works in the Compton Gallery. *Observing the Observers...* ran February 19–May 6, accompanied by an exhibition catalog. A Haystack Observatory historical exhibition was displayed in the adjacent corridor.

Felice Frankel began to work, with support from the Provost and the Associate Provost for the Arts, in the Department of Electrical Engineering and Computer Science and her exhibition, *On the Surface of Things,* continued to travel throughout the United States. In partnership with Boyce Rensberger, director of the Knight Fellowship, a conference on "Image and Meaning: Communicating Science and Technology" is being planned for June 14–17, 2001. The curriculum on visualizing science supported by the NSF neared completion.

Sloan School of Management
In collaboration with the Sloan School of Management and the Admissions Office, the Alan W. Katzenstein Memorial Program sponsored a Residency with Edward James Olmos, actor and activist. Public programs were offered to Latino student groups, Management and Theater students and the MIT community.

The List Foundation Fellowship Program In The Arts
The List Foundation Fellowship Program in the Arts for students of color continued to use the same name with support from the Provost. Fellowships were given to Kevin Choi '01 (management) for a video project and Helen Lee '00 (architecture) to do an installation project including glassblowing and creative writing. Rigel Stuhmiller '99 continued work on her graphic novel, and Zojeila Itzel Flores '00 completed her project on Panamanian Folklore and Dance with a recital in Killian Hall.

Institute Committees
The Committee on Campus Race Relations' Subcommittee for RACE2000! produced an educational video entitled *Making Whiteness Visible: The Conversation No One Wants to Have* with members of the faculty, staff and

students. The tape features interviews conducted by staff person Tobie Weiner and Professor Lora Wildenthal about how white members of the MIT community think about race and racism. The video was introduced to small groups within the MIT community and more widespread distribution and public programming on this topic is planned for the fall.

More information about Special Programs in the Office of the Arts can be found on the World Wide Web at http://web.mit.edu/arts/specprogs.all.html.

Maureen Costello

DEAN OF STUDENTS AND UNDERGRADUATE EDUCATION

For the Dean's Office, the past year saw the culmination of a four-year process that clarified its organization and mission. In October 1999, Margaret Bates, Dean for Student Life, announced that she would retire at the end of the academic year after four and one-half years of service. In January 2000, Rosalind Williams, Dean of Students and Undergraduate Education, announced that she would return to the faculty at the end of the academic year after five years of service.

The timing was not coincidental. Both deans were motivated in part by their desire to complete the organizational redefinition that has been in play since the creation of the "greater Dean's Office" in October 1996. For in the fall of 1999 the structure of the Dean's Office still required modification to address the tendency of student affairs crises and concerns to divert the dean's attention from academic leadership. However, this problem, which was first identified in the Hobbs Search Committee report in the spring 1995, also needed to be balanced against creating the opposite but equally serious problem of a too-sharp division between student life and student learning.

With the opportunity to replace both deans at the same time, MIT was able to re-structure the leadership and develop two well-defined positions–the Dean for Undergraduate Education and the Dean for Student Life. Both deans will report to the Chancellor; both will sit on Academic Council; both will work closely with the Dean of Graduate Students; and both will be dedicated to implementing the institutional commitment to the integration of student life and learning.

The searches have been eminently successful in attracting top-quality candidates. Robert Redwine, member of the physics faculty and most recently Director of the Laboratory for Nuclear Science, becomes Dean for Undergraduate Education on July 1, 2000. Larry Benedict, currently Dean for Student Affairs at the Homewood Campus of Johns Hopkins University, has been named Dean for Student Life effective August 21, 2000. With two first-rate people in these key positions, the long-term prospects for the Dean's Office, as it has now been redefined, are excellent indeed.

This transition in leadership and organization affords us the opportunity to reflect on the past five years. Although these years were often difficult, in the end we successfully achieved our goal of building a bridge from the Dean's Office of postwar MIT to the Dean's Office of the 21st century. There are three foundations to this bridge:

- Organizational clarification, as already described, supported by excellent administration of financial and personnel resources and, for the first time, by focused attention to resource development;
- A strong, explicit commitment to residential and campus life as an integral and critical part of an MIT education; and
- An emerging understanding of the role of the undergraduate dean in fostering educational innovation and in organizing all the forms of support (student information technology, educational technology, physical space, budgetary analysis, staff expertise) that are necessary for excellence in MIT's academic program.

In each case, the construction of the foundation was shaped by contingency as much as by premeditated design. The first organizational pillar was begun in the energetic but somewhat chaotic process of student services reengineering and then became much more intentional and focused after President Vest's key decision to create the "greater Dean's Office." The second pillar—the institutional commitment to student life—began to emerge from the discussions in the Task Force on Student Life and Learning, which began in earnest during academic year 1996–97. The pace and intensity of these discussions were greatly increased following the alcohol- and fraternity-related death of freshman Scott Krueger in the fall of 1997. This catastrophe provided the impetus for President Vest's decision (August 1998) to house all freshmen in MIT-operated residences.

Somewhat less dramatic, but just as important, has been the emergence of higher standards of expectation regarding student conduct, both individual and collective, outside the classroom. The community has gradually been reminded that actions have consequences and that all members of a community are obliged to pay attention to the safety and well being of others.

The third pillar of leadership in education through academics and research has been built, in part, through an intentional collaboration between the Dean's Office and the Committee on the Undergraduate Program. In addition, the decisions of other senior administrators have, at least by implication, highlighted the dean's role. For example, the partnership with Cambridge University, spearheaded by Chancellor Larry Bacow, will include an undergraduate exchange program, and the recently announced creation of a presidential Task Force on Minority Student Success,

chaired by chemistry faculty member and housemaster John Essigmann, will focus attention on the factors that aid or impede the academic success of our minority undergraduate students.

Much of the energy for educational innovation, however, has come from the proliferation of educational technologies and the accompanying influx of resources for their introduction and development at MIT. The next Dean for Undergraduate Education will have the extraordinary opportunity to channel these resources in the most productive directions: to construct physical space in tandem with virtual space; to continue development of student information technologies (especially web-based ones) that complement educational technologies; and to devise modes of evaluation and assessment that will enable MIT to make wise decisions about its overall investment in educational resources. More importantly, the new dean will face the challenge of ensuring that these resources will be committed to the educational ends defined by the collective will and wisdom of the MIT faculty.

During the past academic year, as examples of these larger trends, the following events were especially noteworthy.

STUDENT LIFE

Major gifts were announced. Dick and Dottie Simmons's made a $20 million pledge toward the new undergraduate student residence. In addition, gifts of $4 million from Alex and Brit d'Arbeloff and $2 million from Tom and Anna Gerrity supplemented Al and Barrie Zesiger's increased gift (total of $12 million) in support of the new Sports and Fitness Center.

Continuing efforts to instill and enforce new expectations of student conduct were exemplified by a series of interactions with fraternities (which, in one case, SAE, led to the closing of the house); by the decision of the Committee on Discipline that the Phi Gamma Delta fraternity would never be allowed to return to the MIT campus; by major intervention in East Campus following a student death from drug-related behavior just before the beginning of fall semester; and by protracted, complex, but ultimately successful on negotiations regarding safety issues related to the spring Steer Roast event in Senior House.

NW30 will be renovated to provide a new 120-bed graduate residence. Steven Lerman, Faculty Chair, and his wife, Lori, will be the housemasters.

Less happily, the construction of the new undergraduate residence on Vassar Street has been delayed due to a lawsuit filed by an abutter. As a consequence, the policy of housing all freshmen in MIT-operated residences has been delayed by one year.

Bob and Jan Randolph were appointed as interim housemasters in Bexley Hall following the resignation of Michael and Helen Ouellette for personal reasons.

A banner year for athletics was highlighted by a substantial increase in the department's operating budget coupled with decisions to resurface the outdoor track and begin construction of the Sports and Fitness Center. In addition, athletics began a focused process of strategic planning with the consulting help of David Ellis, MIT alumnus, past president of Lafayette College, and current president of the Boston Museum of Science.

ORGANIZATION

The Dean's Office articulated a strategic plan after an intensive office-wide effort.

Various Dean's Office areas made considerable contributions to MIT's successful reaccredidation by the New England Association of Schools and Colleges.

The Dean's Office and the Department of Athletics hosted well-received presentations to their individual visiting committees (chaired respectively by DuWayne Peterson and Mary Frances Wagley).

Searches for the DUE and DSL, as described above, were completed. In addition, Elizabeth M. Hicks, most recently of Harvard's Kennedy School and before that Deputy Assistant Secretary for Student Financial Assistance Programs in the U.S. Department of Education, was hired as the new Director of Student Financial Services effective June 19, 2000.

Bob Kaynor, formerly of the Planning Office, joined the Dean's Office as Associate Director of Planning.

The Dean's Office participated intensively in the kick-off for MIT's Campaign 2000 in the fall. Later in the year, Kate Eastment, development officer, transferred to the Office of Campaign Giving to facilitiate the opportunities to support the fundraising goals for Student Life & Learning.

STUDENT LEARNING

The first round of funding from the $10 million d'Arbeloff fund for educational excellence was awarded. The process was carried out through close collaboration between the Dean's Office and CUP, with an emphasis on developing proposals that would transform first year education. Six proposals that will substantially enhance first-year advising and science core subjects and broaden the range of academic experiences available to first-year students were funded.

The faculty voted to approve a new communications requirement, which was designed through a two-year process of pilot experiments supervised by a CUP subcommittee chaired by Professors Langley Keyes and Gene Brown. Funding for the coming academic year was secured through President Vest's decision to allot a Hewlett Foundation grant to this purpose. Additional fundraising is being pursued actively.

The Office of Career Services and Preprofessional Advising established a new Premedical Advisory Council that brings together the departments and programs most involved with undergraduates interested in medical careers. This council promises to improve substantially the quality of advising for premeds and other undergraduates who want to go into medically-related professions.

The Enrollment Management Group worked more cohesively than ever before, and in a more timely way, to bring forward its recommendations regarding undergraduate class size, tuition, and financial aid to Academic Council. A follow-on process is expected to produce an even more detailed set of recommendations regarding student financial aid in the coming year.

A process for reviewing MIT's student information systems has begun under the leadership of Registrar Mary Callahan. This will result in a recommendation to the Institute by the end of 2001 on the future of student information processing and management.

MIT celebrated the 30th anniversary of UROP in conjunction with the annual celebration of the MacVicar Day. New MacVicar Fellows named this year include Steve Pinker, Dava Newman, Ernie Cravalho, and Rohan Abeyaratne. The MacVicar Day followed a new format of "teaching demos" that was highly successful.

The event of the year that best expresses the renewed vigor and sense of purpose in the Dean's Office was the Millennium Ball, a special IAP event celebrated in the Stratton Student Center on January 21. Strong support for this event—including funding—came the President's Office; however, the idea for the event came from initiative of the Dean's Office (specifically, from Prof. David Mindell, chair of the Millennial IAP Committee) as did much of the creativity and energy behind its planning. The student center, for that evening, was transformed by a host of glamorously dressed students, faculty, and staff into a grand salon, vibrant with music, art, joy, and sociability, in which could be glimpsed a vision of our educational community at its best. This is a vision that the Dean's Office has sought to realize in all its endeavors for the past five years, and one that it will continue to seek for years to come.

Rosalind H. William

ADMISSIONS OFFICE

The goal of the Admissions Office is to identify, recruit, select and enroll the best students of our type in the world. We continue to have great success despite increasing competition and a wildly fluctuating marketplace. For example, this year Harvard, Brown and Georgetown changed their rules governing Early Action (EA) and as a result, we saw a 44% increase in EA applications, making it impossible to predict EA yield. Though our overall yield has dropped slightly because of this, we still hold the #5 position among our competitors. Here are the main themes this year in Admissions:

- We have continued to struggle with MIT financial aid policies and procedures that place us at a disadvantage in the marketplace. With new leadership in Student Financial Services, we hope to regain our momentum during the coming year.
- We have switched more of our publications and communications to the Web.

- We are reorganizing the Educational Council Office to provide an increased, more effective alumni-presence in the admissions process.

HIGHLIGHTS

- Freshman applications were up 17% to a record 10,679.
- The freshman yield rate is (currently) 59%, down 1% from last year.
- The enrolling freshman class will include 42% women, 18% minorities, a record 10% students designated 'academic superstars'. All states except Arkansas, West Virginia and Mississippi are represented. International students are citizens of 49 countries. If we include US Permanent Residents in this category, 75 countries are represented in the class.
- The freshman admit rate was 16%, the smallest applicant-to-admit ratio in MIT's history.
- We will enroll 38 transfer students. The admit rate was 14%, the yield rate is 84%, as compared to last year's 18% admit rate and 78% yield rate.

- Graduate applications were down 9% to 11,786. The yield is slightly down to 56% from 57% last year. (I speculate that this is the effect of the continuing strong economy).

Educational Council Statistics

- Currently there are a record 1,909 Educational Counselors (ECs) representing 50 states and 54 countries; 24% (454) are female; and 4% (80) are minorities.
- ECs interviewed 94% of all applicants, up from 90% last year.
- ECs arranged 83 central recruiting meetings for admissions staff around the US in 76 cities last fall. Over 10,000 people attended these sessions. ECs also sponsored 51 admitted student receptions this spring and 7 enrolling receptions this summer.

SUCCESSES

We were able to document a direct correlation between our admissions numeric index and future MIT GPA. As a result, we made a change to the methodology by which we admit undergraduates. Last year 8% of the enrolling freshman class had numeric indexes in the lower half of the pool; this year, that number was just 2%. This means that this entering freshman class has the highest overall numeric index on record, and therefore, should be most likely to do well at MIT.

It was an extraordinary year for minority freshman admissions. We had a 20% increase in minority freshman applications, the highest on record at 739. This includes record high applications from African American and Mexican American students. We also have the highest minority yield ever at 62%, 3 percentage points higher than our overall yield. It is important to note that these students are well within the top half of the numeric index of our admit group, the strongest class in MIT's history. Among our peer institutions, we have the 2nd highest yield for African Americans after Harvard, and the highest yield for Mexican Americans.

We had the greatest faculty involvement in admissions in the 22 years that I have been in the Admissions Office. We doubled the number of faculty readers and their attendance at selection.

This year the Admissions Office expanded its web presence by:

- Completing the first stage of our admissions web site redesign.
- Choosing one vendor (CollegeNet) for both graduate and undergraduate admissions to provide an electronic application that will be directly downloaded into our database.
- Expanding electronic application status-checking to include financial aid and the Educational Counselors.
- Hiring a Web developer. In addition, we have started to implement a new policy that recognizes shifting skill sets for admissions professionals by requiring new admissions staff members to have web experience. We has hired three new staff for the fall.

Once again all admitted prefrosh were invited to attend the Campus Preview Weekend. In addition to being one of our top yield events, Campus Preview Weekend is one of the few events that unites the undergraduate communities. Forty-two percent (42%) of the admitted class chose to attend the weekend and 73% of them have chosen to enroll this fall. Last year 43% of the prefrosh attended Campus Preview Weekend and 73% chose to attend MIT.

Nearly all of the graduate departments now use the graduate admissions database. We have worked with the Graduate Students Office and several departments in the School of Science to help them understand yields within certain graduate applicant populations.

More information about this department can be found on the World Wide Web at http://www.mit.edu/admissions/.

Marilee Jones

ATHLETICS, PHYSICAL EDUCATION, AND RECREATION DEPARTMENT

The Department is dedicated to providing adaptable, high-quality, student-oriented physical education, athletics, recreation and intramural programs that encourage opportunities for participation, competition, confidence, and leadership while enhancing the MIT athletics and health fitness environment for the entire MIT community.

For the past five years the department has reported to Rosalind Williams, Dean of Students and Undergraduate Education. The department's association with other units in ODSUE has enhanced the quality of the educational experiences for student-life and learning and community services at MIT. Beginning in August, the department will report to Larry Benedict, the newly appointed Dean for Student Life.

STRATEGIC OBJECTIVES AUDIT FOR 2000

The Institute gave final approval for the construction of the long awaited Sports Fitness Center. Ground breaking is scheduled for late Fall 2000, and completion is slated for Summer 2002. In preparation for the construction of the new facility, duPont Athletic Center is currently undergoing extensive renovation. Special thanks go to Chairman of the Corporation Alex D'Arbelof '49 and his wife Brit '61, Dr. Tom Gerrity '63 , and Al Zesiger '51 and his wife Barrie for their financial contributions that will allow construction to proceed.

The Steinbrenner track is being renovated and reconstructed. Improvements include the addition of two creating a total of eight lanes, construction of a new event runways. In addition, event venues will be moved and the current scoreboard will be replaced. Completion is scheduled for Fall 2000.

The indoor track at the Johnson Athletic Center is also being resurfaced. Completion is expected before the start of indoor track and field season in late Fall of 2000.

In the Fall of 1999, a new synthetic turf was installed on Barry Field. New movable bleachers and a new scoreboard were replaced at the same time.

During the Summer of 1999 the Baseball and Softball fields were brought to grade, and in the Spring a bullpen, a new scoreboard and new bleachers were added for Softball.

Several personnel changes have occurred. Physical Education administrative assistant Lisa Wilson and Day Camp/Intramural Administrative Assistant Sandy Tenorio accepted other positions at the Institute. Bernice Ward replaced Tenorio and a full-time replacement for Wilson is currently being sought. Service Assistant Charles Hancock left in June to return to his home state of Texas. Dave Henry was hired as an assistant in the Sports Information Office replacing Peter Charbonneau who resigned to take a position at Boston University. Athletic Training Coordinator Cristina Monterroso resigned to take a teaching position at La Sell College. A search is underway to fill her position.

Among the coaching staff, Director of Crew/Lightweight men's coach Stu Schmill '86 resigned to take a position with the MIT Alumni Association. Doug Vincent '89 replaced Schmill as coach on an interim basis. A search for a one-year interim appointment to replace Vincent is underway. Kyle Welch '90 left his position as Assistant Sailing Master and Coach of Women's Sailing at the conclusion of the academic year to pursue a career in computers. John Holland resigned as coach of pistol at the conclusion of the academic year, and Jim Malo resigned as rifle coach (part-time). Searches for these three positions are on going. Assistant Professor Paul Slovenski picked up women's track & field coaching duties in addition to his responsibilities for women's varsity cross country which he assumed in September '99. Susan Lindholm will continue in the position of interim head coach of women's varsity crew through the 2000–2001 academic year. In addition, Lindholm will be the Coordinator of Alumni Activities for Crew and Assistant Coordinator of Boathouse Operations. Gordon Hamilton will assume the duties of Coordinator of Boathouse Operations and will assist Lindholm with Alumni Activities. Bruce Chalas replaced Ken Bellerose in the

part-time position of coach of Golf. Following 18 years of service, Fran Molesso resigned from the part-time position of coach of Men's Gymnastics.

During the Summer of 1999 all sub-varsity teams were eliminated and practice squad and travel party sizes were restricted by the department for budgetary and facility use purposes.

MIT hosted approximately 40 events sponsored by non-MIT affiliated groups in Athletics Department spaces during the year. These events underscore the strength of town and gown relationships. In addition, the department hosted over 90 non-intercollegiate varsity special events. Overall more than 13,500 reservations were placed for Department of Athletics facility usage throughout the year.

Sales of Athletic Cards remained consistent with recent years. A total of 7,556 cards were sold. The Department Business Office fully implemented the SAP Institute accounting package. The MIT VISA credit card was distributed to staff members, increasing staff flexibility and reducing costs and payment bottlenecks. In addition, the department developed localized databases for event scheduling, deposits and other special transactions. The department standardized the voucher payroll process and distributed responsibility and accountability for student payroll.

PHYSICAL EDUCATION

Physical Education (PE) registrations for 1999–2000 were 7,924, up nine percent from 1998–99. This number represents a consistent trend when viewed in the context of the previous five years.

No undergraduate student was denied graduation solely because he or she failed to complete the PE requirement. A study of peer academic institutions conducted for the Department Visiting Committee revealed that approximately 40% of our peers have a PE requirement that is more rigorous than that of MIT and roughly 55% have no PE requirement at all. Most peer institutions no longer have a swim test requirement.

During 1999–2000 a Scuba Instructional outsourcing agreement was struck with United Divers, Inc. This agreement relieved the department of the burden of maintaining a scuba rental business.

INTRAMURALS AND CLUB SPORTS

Intramural sports continue to attract strong student interest. During 1999–2000, 8,500 students (multiple registrations) participated in 22 intramural sports programs.

Financial support guidelines for Club Sports program needs (developed in 1997–98) continued to be implemented. Of the 46 programs registered this year, 20 competing Club Sports received financial assistance. Participation figures were up 4.7% from 1998–99 and 39% of participants were women (up 1%).

STUDENT-ATHLETE ACCOMPLISHMENTS

The outstanding performances by our student-athletes are too numerous to mention comprehensively in this document. Highlights of the 1999–2000 academic year, however, are as follows:
Caroline M. Purcell '02 won the National Collegiate Athletic Association Women's Sabre fencing individual championship.

Nikolas O. Kozy '00 was named the winner of a Burger King College Football Scholar /Athlete Award. It is the third consecutive year that an MIT player has won the award that carries a $10,000.00 donation by Burger King to the MIT General Scholarship Fund. Kozy was also named recipient of an NCAA Postgraduate Scholarship.

Eric L. Chen '00 (tennis) was also selected for an NCAA Postgraduate Scholarship and was named the national Division III Arthur Ashe Sportsmanship Award winner by the Intercollegiate Tennis Association.

Alan A. Sun '00 led a list of four MIT sailors to be named All-America. Sun, the first African-American to be so honored, was also named as winner of the Sportsmanship Award given by the Intercollegiate Yacht Racing Association.

The MIT men's tennis team qualified for the NCAA Division III National Championship Tournament. MIT hosted the first rounds of the tournament and subsequently traveled to Kalamazoo, MI to compete among the final eight teams in the country. Coach Jeff Hamilton was named the National Division III Coach of the Year.

The women's nordic ski squad won the U.S. Collegiate Skiing Championship. The men's indoor track & field team won the New England Division III championship, and the men's fencing team won the New England Championship.

The women's and men's tennis teams, men's cross country team, and men's swim teams all won New England Women's and Men's Athletic Conference championships. The men's hockey team won the New England Collegiate Hockey Association championship.

Seven MIT student-athletes were named to GTE College Sports Information Directors of America Academic All-America teams.

Fourteen student-athletes earned All-America honors.

SELECT FISCAL YEAR 2001 PLANNING OBJECTIVES

The department will work with consultant David Ellis to develop a comprehensive management and business strategic plan that will shape operations for the foreseeable future.

In addition, the department will continue its efforts to diversify its staff through the identification, recruitment, and employment of more women and minorities in administrative, management, head-coaching and teaching positions.

The department will also continue to develop of a planned approach for funding the Sports Fitness Center, along with the renovation of existing facilities based on the Department of Facilities audit results. As part of this effort, the Department will explore marketing and promotional activities aimed at creating revenue streams to support facilities expenses.

The department will continue to improve the efficiency and effectiveness of daily operations through an on-going review of processes and utilization of computer technology.

The department will develop a planned approach to involve faculty/coaches and other staff in research and other scholarly professional endeavors.

The department will continue to participate actively in the planning and development of the Center for Sports Innovation.

In addition, the department will continue to improve existing communication pathways between students and the Department Administration.

Finally, we look forward to forging a positive and mutually beneficial working relationship with new Dean of Student Life Larry Benedict and the offices under his purview.

More information about the Athletics, Physical Education and Recreation Department can be found on the World Wide Web at http://web.mit.edu/athletics/www/.

Richard A. Hill

CAMPUS ACTIVITIES COMPLEX AND CAMPUS DINING

The mission and purpose of the Campus Activities Complex (CAC) is to be a center of campus life for students, faculty, staff, alumni/ae, retirees and guests. The Report by the Task Force on Student Life and Learning describes the Institute as a triad comprised of academics, research and community. In this vision of MIT's educational process, the concept of community is given critical new importance. Through its programs, services, and facilities, CAC supports community by providing opportunities for interaction as well as the exchange of ideas, concerns and interests. With the support of its affiliated volunteer organizations and the CAC Advisory Board, the department strives to foster individual growth, build community spirit and improve the quality of life for all members of the MIT community.

As a unit within the Office of the Dean of Students and Undergraduate Education (ODSUE), the Campus Activities Complex (CAC) has had new opportunities to further realize its mission. CAC has established vital links and affiliations that have enabled both the CAC and other student life departments, especially Residential Life and

Student Life Programs (RLSLP) and Athletics, to serve the MIT community more effectively through improvement of services, programs and operations.

The CAC Advisory Board, composed of student, faculty and staff representatives, chaired by Seth M. Bisen-Hersh '01, continued its critical role of providing community input and feedback on direction and issues facing the department. The board assisted with the planning for the renovation of the 24 Hour Coffeehouse and the replacement of furniture in Lobdell Dining Hall. Members of the board also represented the MIT community on the selection committees for several open CAC staff positions.

COMMUNITY PROGRAMS AND SERVICES

The CAC provides a comprehensive program of educational, cultural and social activities to build a sense of community among students, faculty, staff and retirees. The programs and services that contribute to this objective include the Institute Awards Convocation, the Student Art Association, MIT Hobby Shop, CAC Program Board, the Community Giving (United Way and Other Charities) Campaign, MIT Activities Committee (MITAC), Quarter Century Club and the Association of MIT Retirees.

ARTS AND RECREATION

The Student Art Association (SAA) again reached capacity enrollment of 1,100 students. The SAA is in the process of developing capability to support digital photography. The Wiesner Student Art Gallery exhibited a variety of student artwork, including photography, drawings, painting, ceramics and woodwork. Works of the winners of the List Fellowships and the Schnitzer Prizes in the Visual Arts highlighted the exhibition season. We are adding two new drawing courses and a photo-toning, hand-coloring and digital photo class to our fall offerings.

The MIT Hobby Shop had its largest membership ever during the Spring Term with over 200 members. Four new classes were added. During the Fall term, Director Ken Stone and Professor John Vander Sande taught a new Freshman Advisory Seminar entitled "New England Furniture before the Revolution" (3A.19). Students were introduced to early New England history, lifestyles and furniture through tours of Professor Vander Sande's circa 1694 home. Students then made their own period-style document boxes, using only hand tools and following historic woodworking practices. The Hobby Shop also offered "Metalworking" and "Tuning a Handplane." Ken Stone also taught "Introduction to Green Woodworking" (SP.743), in which undergraduate students, using only hand tools, built post and rung stools. In addition to "Introduction to Furniture Making" and "Speaker Building," two IAP classes regularly offered by the Hobby Shop, the Hobby Shop collaborated with Professor James Makubuya's "Music of Africa" class (21M.293) for the second year. Students worked in the Hobby Shop to construct working African instruments. The shop also helped out the Aeronautics and Astronautics Department and the Mechanical Engineering Department during their shop renovations by accommodating students in 16.00 and 2.75 and increasing shop hours. For the first time, the Hobby Shop is offering summer classes to the entire MIT community.

PROGRAM BOARD AND SPECIAL EVENTS

Under the leadership of Rita Lin '00 and Sonia Garg '02, the CAC Program Board planned and produced a variety of programs and activities. The board sponsored the College Bowl, Take a Professor to Lunch Week, Halloween and Valentine events, study breaks in the Conor Moran Lounge of the Student Center, the IAP Games Tournament and entertainment in the 24-Hour Coffeehouse. The board co-sponsored several Swing Dances with the MIT Ballroom Dance Team and the President's Office. Additionally, the board sponsored two students competitors to the Association of College Unions International's National Table Tennis Tournament.

During the Institute Awards Convocation 51 students, faculty, staff and organizations were honored by presentation of 30 different awards. The Laya Wiesner Award for Community Service was awarded for the first time to Bonnie Walters, Associate Dean for Freshman Advising.

This year, the Campus Activities Complex helped coordinate and produce two major Institute events. The Millennium Ball transformed the Stratton Student Center into three floors of entertainment featuring historical films and exhibits, magicians and music from the 1940's to the 1990's for over 2000 students, faculty, staff and guests. During the annual Spring Weekend festivities, the Johnson Games returned to MIT for the third time. Twelve hundred people participated on thirty teams and competed in games such as "Who Nose?" and "Is That Your Final Answer?"

The new MIT Beaver Mascot Costume, designed by Solar Olugebefola '99 and Jessica Wu '98, was debuted during the opening ceremonies of the Games. With the assistance of student staff, the new beaver mascot will be available to the community for rental use on a scheduled basis.

SPECIAL COMMUNITY SERVICES

The Office of Special Community Services (OSCS) is responsible for augmenting the quality of life of MIT faculty and staff on campus, at Lincoln Lab and at other off-campus affiliate locations. During the year, OSCS continued to serve the MIT community by organizing and supporting a variety of important community activities, in addition to promoting community service and volunteer opportunities to all segments of the MIT community. This year, the office also focused on developing user-friendly web pages highlighting OSCS' programs and services.

The MIT Activities Committee (MITAC), with assistance and leadership from the campus Co-Convener, Muriel Petranic, and the Lincoln Laboratory Co-Convener, Karen Shaw, organized more than 73 events for approximately 5,424 members of the community. This represented an increase of 900 participants. Event highlights included: Joey and Maria's Comedy Wedding held at La Sala de Puerto Rico for nearly 200 people, WGBH (Channel 2) Membership Telethon Drive held in March, the second annual Mother's Day Sunday Brunch held at the MIT Faculty Club for over 300 people and the second annual Father's Day Barbecue at Six Flags New England. During the year, OSCS implemented procedures for accepting credit card sales for customer convenience at Lincoln Laboratory and produced the second annual MITAC "year-at-a glance" calendar.

MITAC members stepping down this year included Maria Raposo of the Graduate Students Office on-campus and Michael Clifford who served as MITAC's first Lincoln Laboratory Co-Convener for three years prior to the appointment of Karen Shaw. Mary E. Collins of Lincoln Laboratory joined MITAC this year..

The annual Community Giving at MIT Campaign, formerly known as the United Way Campaign, ran from October to February and reached over 100% of its goal of $340,000. In the Fall, Professor John Deutch was appointed Campaign Chair, and the former Campaign Chair, Bill Wohlfarth, became the Campaign Cochair. Four new members joined the Steering Committee: Kathryn Willmore, Vice President and Secretary of the Corporation; Professor Henry Jacoby, Sloan School; Professor Kenneth A. Smith, Chemical Engineering; and Lease Plimpton, Lincoln Laboratory. A book sale, clothing drive, raffle drawings and solicitor thank you party were held during the Campaign to help raise community awareness. As a "pilot program" this year, the MIT Community Service Fund (CSF) was listed as an option for giving through our Community Giving Campaign. The campaign goal was exceeded, and there was also an increase in the number of Leadership Givers (those that give $1,000 or more). In addition, for the second consecutive year, MIT was awarded the "Spirit of Sharing Award" by the United Way of Massachusetts Bay.

The Quarter Century Club (QCC) Office inducted 100 new members in March, bringing the membership roster to over 2,800 active and retired members. Events held during the year included the annual Summer Picnic, the Silver Club High Tea for Ladies and the Holiday Gathering. The W. R. Dickson Retiree Education Fund, established to help QCC retirees pursue their educational goals, awarded two grants. In May, the President of the QCC, James J. Fandel, and the Recording Secretary, Mary Frances Daly, stepped down from their positions after many years of long and dedicated service. The Officers and Board of Directors elected Professor Anthony P. French as the QCC's new President. The Recording Secretary position will be filled at a later date. In addition, five new members were elected to the Board of Directors: Frederick I. Crowley, Yvonne L. Gittens, Gerald D. Johnson, Travis R. Merritt and Muriel A. Petranic. The QCC President and Board of Directors and President and Mrs. Charles M. Vest co-hosted the annual President's Retirement Dinner at the MIT Faculty Club for 108 retiring members.

During the past year, OSCS has assumed responsibility for managing Talbot House reservations. Talbot House, a Vermont retreat, is used nearly every weekend, particularly during the fall and winter months. January 2000 witnessed a near 100% occupancy rate. Ten different MIT groups booked the house for weekdays as well as weekends.

The Association of MIT Retirees, co-chaired by Dorothy Bowe and Walter Milne, completed its sixth year with the Institute. This past year, the group updated membership lists, which now includes 610 dues paying members, and released a supplemental directory. The fall program featured a seminar, taught by representatives from the Secretary of State's Office, about sophisticated approaches used to relieve people of their assets. Sally Hansen continued to produce a monthly newsletter for those interested in volunteer opportunities. In addition to working with the Public Service Center, efforts were made this past year to seek out suburban volunteer opportunities. The Association

continues to mail the "Senior Focus" newsletter that identifies activities and programs of interest to retirees. This year's travel program included day trips to the Boston Public Library, Trinity Church, the Old State House, the New State House, Essex and Tanglewood. Volunteer staff assistance from Dotty Bowe, Jane Griffin, Sally Hansen, Joan Loria, Roberta Bruce and Joanne Miller facilitated the ongoing work of the Association.

FACILITY AND EVENT OPERATIONS

CAC operations staff was available 24 hours a day, seven days a week to provide event planning, support and supervision to more than 12,500 events attended by over 700,000 people. In addition, CAC was responsible for coordinating the operational and logistical aspects of many of the Institute's major events, including Commencement, Tech Days, Freshman Orientation, Spring Weekend, Massachusetts State Science Fair and Alumni Reunions. CAC also coordinated and supported many conferences including the Special Olympics, Enterprise Forum and the dedication and ground breaking for the Ray and Maria Stata Center. The Operations Staff also collaborated with the Office of Government and Community Relations to bring more Cambridge and Boston based programming to campus.

CAC also continued to maintain and service the Stratton Student Center, Walker Memorial, the MIT Chapel, the Religious Activities Center, Kresge Auditorium and Tang Center. Lighting, carpeting and seating in many of our common areas and in some of our event rooms were upgraded. In Lobdell Dining Hall, tables and chairs were replaced and the hall was re-carpeted. Morss Hall patios and the main hall were outfitted with the furniture removed from Lobdell. In addition, facility use evaluation and planning continued its effort to schedule and use limited space more effectively. To that end, CAC collaborated with Residential Life and Student Life Programs (RLSLP), Athletics, Campus Police and the Registrar's Schedules Office to coordinate event logistics.

FACILITY RENOVATION

The first phase of the Kresge Renovation project was completed making the facility ADA compliant. The project included installing sophisticated sound and light equipment in both Main Kresge and Little Theater. Rehearsal rooms A and B were renovated with new floors, lighting and sound equipment. In addition, a green room was made available for presenters and performers. The Kresge auditorium restrooms were also refurbished. A new air handling system was installed in the MIT Chapel to provide air conditioning and better air quality flow. The first level of the chapel is now ADA compliant. This past year, CAC focused on improvements to Walker Memorial. The Morss Hall patios received new enclosures and railings. WMBR Radio Station renovations added a new control studio and acoustic improvements to the performance studio. CAC also upgraded the lighting, air conditioning, carpet, furniture and ceiling fans in the Graduate Student Council Lounge and is currently undertaking similar improvements in the Black Students' Union Lounge. Renovations have begun on the 24-Hour Student Coffeehouse and the Networks Dining Facility. Both Facilities should be ready to welcome students back to campus in the fall.

SCHEDULING AND EVENT MANAGEMENT SYSTEM

The Event Management System (EMS) serves as the primary scheduling platform for both the Campus Activities Complex and the Department of Athletics. This unified system enables the two departments to maximize the schedulable facilities and provide improved customer support. In addition, EMS produces reports used by Campus Police, Conference Services and Residential Life and Student Life Programs to facilitate event planning and implementation. During the Fall of 1999, EMS basic and advanced training was offered to current system users, and web capability was demonstrated. In December 1999, the system was upgraded to version 6.12.1113.

ADMINISTRATIVE AND FINANCIAL OPERATIONS

The CAC financial operations group concentrated on improving management and client reporting, implementing new systems and developing strategic plans outlining our business and program initiatives. Specifically, we utilized SAP to improve reporting to our event clients, department staff and Institute senior management. Additionally, the group was involved in the upgrade of the declining balance system and the development of the Office of Campus Dining five-year business plan. A collaborative project was initiated with the Controller's Accounting Office to identify partnership opportunities with banks in an effort to improve banking services for students. Staff also participated in an interdepartmental project that investigated the viability of creating a "one-identification card" campus card system. This project integrated the efforts of CAC, the MIT Card Office, the Department of Facilities, Information Systems, and others seeking operational efficiencies and cost effectiveness solutions for the current disparate card providers. In an effort to fill the two vacancies in the Student Center's retail portfolio, specialty retail consultants were retained to perform a marketing study and leasing strategy to implement prior to the 2000–01 academic year.

BUSINESS SERVICES

The administrative and financial operations group supported both the programmatic and fiscal aspects of the department's business services. The CAC met retail business needs through management of the MIT Activities Committee, the 24-Hour Coffeehouse, the Gameroom, the Source Box Office and the Student Center Lobby Vendor Program. Additionally we enabled CAC to fund other programs and services, including the CAC Program Board, and to provide growth and development opportunities to our student employee staff.

CAMPUS DINING

The search for a Director for the new Office of Campus Dining was successfully concluded. This represents the first step in establishing and developing the Office of Campus Dining as the central coordinating body for dining services on campus.

The Office of Campus Dining had a busy first year of operations as it worked to demonstrate immediate improvements in dining services and planned strategically for development and acceleration of Campus Dining as a tool for social interaction and community development. MIT subsidies to operate its dining services were reduced by over $200K when compared to last fiscal year.

A Request for Proposal process was conducted to select MIT's prime food contractor. After considerable review, the entire contract was awarded to ARAMARK. Final contract negotiations are currently being completed. With the exception of leased spaces and student run businesses, all dining locations are now operated by ARAMARK. The new contract provides for shared fiscal responsibility of operating results and for greater oversight and direction from MIT in maintaining and enhancing food and service quality. This agreement saved MIT approximately $100,000 in contractor subvention costs this year.

In order to be Y2K compliant, the Office of Campus Dining upgraded its card reader point of sale system to the next generation Diebold system. A cross-functional committee that included representatives from MIT Information Systems, the Controller's Accounting Office and the MIT Audit Division selected the Diebold system based on the strength of its data security encryption handling. The new hardware will also be compatible with the next system software currently in beta testing at other institutions.

The Dining Implementation Group identified three strategic capital renovation projects: residential dining in McCormick, the Refresher Course at Sloan, and the Lobby 7. A five-year business plan process that outlined potential strategies for development of residential dining and retail venues was developed. Specific attention has been paid to Dining's role in residential community building and to the flexibility of services to accommodate MIT's diverse academic lifestyles. Campus Dining and the Undergraduate Association leadership co-sponsored a Student Advisory Committee meeting this past year to discuss our student center renovation project. Our office plans to convene this group again this fall to ensure on-going student involvement in our initiatives.

Campus Dining has also been active in the design and development of numerous capital projects. Working with the Founders Group, a new dining operation for the 2002 residence was developed. An assessment and recommendation to include a foodservice operation in the Stata Center was endorsed by the Provost and will add a new 6000 sq. ft. dining operation. Design and planning to renovate a Stratton Student Center dining operation was also completed, and construction will be finished in August of 2000. This project is MIT's first dining renovation in the last five years. A proposal for a coffee kiosk in Lobby 7 was developed with our food contractor. Construction is planned for this fall.

Campus Dining conducted several special meal programs pilots this year: a dinner program at McCormick on Monday nights, a two night/week dinner program at Walker Memorial for East Campus residents and a lunch program 4 days a week at the Faculty Club for the Sloan community. All have met with community approval, and will be developed further this coming year.

The food trucks, an MIT institution, were brought under license agreements to operate on campus after a Request for Proposal process. This has resulted in a greater diversity and quality of food offerings. Due to greater competition, three of the four trucks on campus have invested in new vehicles. Our new contracts also provide for improved oversight in the areas of sanitation, safety, operating hours, food quality and menu diversity and value. The trucks were moved to a new location due to Stata Center construction. New benches and landscaping near the Biology Building made the area more pleasant for food truck patrons.

STAFFING AND STUDENT EMPLOYMENT

This year, CAC underwent several staffing changes. Among administrative staff, Keith Lezama was hired as Operations Manager for evenings and weekends, and Susan Marcy joined CAC as Assistant Manager for Event Planning. Lucille O'Hehir transferred from Campus Dining to the School of Engineering. Both Daniel Conceison, Assistant Operations Manager, and Ricky Murphy, Operations Supervisor, left the Institute to pursue other career opportunities. At year end, four administrative positions–Dining Manager, Assistant Operations Manager, Operations Supervisor, and the newly created Systems Manager–were all in national search processes.

Within support staff, Diane Tavitian transferred from the School of Architecture and Planning to become an administrative assistant in the Office of Special Community Services. She replaced Julie Coiro, who transferred to the Sloan School. There were also numerous changes within the Department of Facilities service staff assigned to CAC.

CAC continued to provide employment opportunities for over 75 students. In addition, CAC offered a Graduate Assistantship to Lesley Nye, a graduate student in the Higher Education Administration programs at Harvard University. In her role, Lesley provided programming support for the Program Board and the Wiesner Student Art Gallery.

More information about Campus Activities Complex and Campus Dining can be found on the World Wide Web at http://web.mit.edu/campus-activities/www/.

Phillip Walsh

CHAPLAINCY

The Chaplaincy at MIT remained stable during the year past. Student involvement remained high and some new ground was broken. The Reverend Jane Gould, The Reverend John Wuestneck, Mr. Suheil Laher and Rabbi Joshua Plaut took part in a Freshman Seminar led by Dean Robert M. Randolph. The seminar called "The Abrahamic Faiths: Conversations between Christians, Jews and Muslims" was very successful and made real the types of conversation the Religious Life Center was created to foster. Dean Randolph and The Rev. Wuestneck served as advisors for the fifteen students enrolled in the seminar. In January representatives of the three faiths led a public discussion with students which for the first time attracted a large Muslim audience.

In December 1999 the MIT Religious Activities Center (RAC) was featured in an article appearing *in The Chronicle of Higher Education.* The article "Pluralism and Prayer Under One Roof" cited MIT for the leadership it has shown in creating multi-faith worship and study space. *Creating Multi-faith Spaces*, a handbook of case studies, was published in the spring and is available through Wellesley College.

At the end of June The Reverend Betsy Draper left the Southern Baptist Chaplaincy and Sister Kathleen Crowley left the Tech Catholic Community. Both will be replaced during the coming year. The Reverend Connie Parvey returned to the Lutheran Chaplaincy after recovery from heart surgery.

The Technology and Culture Forum concluded another successful year under the leadership of The Reverend Jane Gould. Along with Hillel, they continued to lay the foundation for a major fund drive to underwrite their work at MIT.

Hillel sponsored 112 individual events over the course of the year. They continued to offer kosher meals twice a day and nine Judaic classes per week. During IAP, they took 20 MIT students to Israel for a ten day tour.

The three worshiping communities sponsored a total of 16 services each week.

STUDENT DEATHS

Eight graduate and undergraduate students died during the year. Four were not currently enrolled, but all were known to the community and each death impacted friends and faculty. Memorial services were held on campus for five of the students. This is not an unusual number of deaths but we are a small community and such losses have great impact. We mediate that impact by helping students attend memorial services off campus and by holding services on campus when it is desired and possible. In these efforts we are aided by the Chaplaincy and by the Medical Department.

Following is a list of the students and the circumstances of their deaths.

Amy Beth Segal – July 21, 1999
34 year old graduate student at The Sloan School of Management, died of cancer at the M.D. Anderson Cancer Center in Houston, TX.

Richard Guy – August 31, 1999
Class of 2001 at East Campus. A memorial service was held at MIT.

Benjamin Krinsky – September 3, 1999
Died of a brain tumor at home on Long Island, NY. A memorial service was held at MIT.

Irina Libove – December 28, 1999
23 year old graduate student in the Department of Biology; died in a fall on the slopes of Pico de Orizaba (also known as Citaltepetl), a Mexican mountain.

Seth L. Koran – February 9, 2000
Chemistry major and member of Tau Epsilon Pi on formal leave of absence from MIT since August 1999; suicide at

home after longstanding battle with depression. A memorial service was held at MIT.

Christopher James Millard – March 24, 2000
Not a registered student; suicide at PB; degree awarded posthumously at graduation ceremonies in June 2000. A memorial service was held at MIT.

Elizabeth A. Shin – April 14, 2000
Class of 2002; suicide at Random Hall. A memorial service was held at MIT.

Sara Mae Bush – June 22, 2000
Graduate student on medical leave; victim of truck accident.

Robert Randolph

COUNSELING AND SUPPORT SERVICES

The mission of Counseling and Support Services (CSS) is to provide personal counseling to all students in a highly competitive and stressful environment. This counseling seeks to dignify each student in his or her efforts to learn within both academic and personal contexts. Personal support includes counseling students on a range of issues, including academic, psychological, interpersonal, financial and even career matters.

The 1999–2000 year proved to be a large challenge for a considerable segment of this community. From late summer through the spring, three students who were on leave or unregistered died. All had close ties to their living groups, the student body, or friends on campus. The death of a fourth student near the end of the spring academic term left others shaken by the incident and coping with their grief. Throughout the year, Counseling and Support Services (CSS) and MIT Medical's Mental Health Service, saw high numbers of counselees and patients in distress. CSS coordinated their efforts with the Medical Department and interacted closely with faculty, house masters, student family members, campus police, chaplains and hospital staff. Counseling deans also teamed with medical and other professionals to visit dormitories and fraternities that had been directly affected by the deaths of members of their living groups. In addition, the office collaborated with Student Financial Services to help students who were impacted by the financial hold policy and whose life circumstances caused them to be in need of further financial assistance. CSS continued to support the Committee on Academic Performance (CAP), supporting review of matters where academic and personal issues intersected. Nightline, the peer counseling hotline, continued to receive supervision from the CSS staff. The office also presented a range of workshops and training sessions to address student and staff needs.

Ms. Lynn Roberson, Coordinator of Programs and Support for Women Students, met with large numbers of women students, helping them to identify counseling and other relevant support resources. Additionally, she and Dean Blanche Staton of the Graduate Students Office co-led the Graduate Women's Support Group. Lynn also joined Dr. Bina Patel of Mental Health and a concerned faculty member to initiate the first gathering for South Asian women

students. It was exceptionally well attended. This year also marked the introduction of a new workshop series, "Honoring the Great Feminine." The program is inter-disciplinary, featuring aspects of anthropology, history and psychology. It explores the roots and dimensions of what is regarded as the feminine and examines critically important role models, enabling participants to develop self-esteem. Consultant Doris Roach also hosted a "Day of Renewal for Women of Color," a workshop for managing stress and honoring women of color.

Dean Ayida Mthembu worked with the Campus Committee on Race Relations (CCRR) where, in addition to contributing to several ongoing agenda items and projects, she oversaw the awarding of CCRR grants for improving the state of race relations in the MIT community. She also continued efforts devoted to Race 2000 and worked to help plan, organize and facilitate the annual Black Women's Retreat for graduate and undergraduate students. In addition, she served as an advisor to under-represented minority student groups from other backgrounds and assisted them with the planning and organization of cultural celebrations and other relevant events. Dean Arnold Henderson, Jr. maintained his long-standing involvement with the Martin Luther King Committee, especially the MLK Leadership Awards Subcommittee, and assisted the organization with its yearly celebratory breakfast. In addition, he attended the weekend LUCHA Symposium. Deans Mthembu and Henderson also participated in the Chocolate City Reception.

STAFF DEVELOPMENT AND OUTREACH

Dr. Jacqueline Simonis, Associate Dean for Counseling Supervision and Training, continued to develop timely and innovative staff in-service training. These sessions featured a discussion of the art and practice of psychotherapy by Dr. Suzanne Repetto of Harvard University's Bureau of Study Counsel, a presentation on psychotropic medication by Dr. Amy Brager and Dr. David Henderson of MIT Mental Health and a workshop on legal issues for college staff working with student with disabilities conducted by Barbara Roberts, Coordinator of Disabilities Services and Attorney Salome Heyward. Dean Simonis also facilitated meeting between the staffs of CSS and Harvard's Bureau of Study. In addition, she attended a symposium for mental health professionals that addressed the significance and impact of word choice in psychotherapy sessions.

Dean Kimberly McGlothin supervised Nightline staffers. She also conducted training sessions for graduate resident tutors, placing special emphasis on helping tutors identify resources for students with serious personal or psychiatric issues.

Dean Arnold Henderson, Jr. participated in a panel discussion at the September Orientation for New MIT Faculty. He was also a guest speaker at the departmental administrators' luncheon where he discussed the various functions of Counseling and Support Services and how to get help when a student has a serious personal or psychiatric problem. Henderson also participated with Margaret Bates, Dean of Student Life, Dr. Peter Reich, Chief of MIT Mental Health and Dr. Margaret Ross, staff psychiatrist, in a training session for graduate tutors led by Dean Carol Orme-Johnson.

Deans Simonis and Henderson also participated in the search process for a new counseling dean for CSS. The first search process in the fall of 1999 was unsuccessful, necessitating a reopening of the search. The second attempt resulted in the hiring of Dean Kunya Des Jardins, who accepted the position in late June.

PROGRESS ACHIEVED AGAINST GOALS

- To counsel and advise undergraduate and graduate students on a wide range of personal, academic and career matters.
- To consult with Institute faculty, staff, family and friends on a variety of personal issues; on the necessity for intervention and the provision of support; and on the potential impact of personal difficulties on academic life.
- To respond to personal student crises and emergencies, assessing risk, offering advice and assistance to the MIT community as needed, and making appropriate referrals to medical personnel and others.
- To provide special support for women, minority, and gay/lesbian/bisexual students, and for students with learning disabilities.
- To promote and support the concept of peer counseling through training, supervision and the administration of peer services at MIT.

The staff worked very hard to make a sustained and committed effort to meet its established goals during a year characterized by many—both in and outside of the office—as exceptionally demanding and challenging. CSS is very grateful for the thoughtful attention and strong support that it received from Chancellor Larry Bacow, Dean Rosalind Williams and Dean Margaret Bates.

FUTURE PLANS

The addition of a new counseling dean to the CSS staff should help the office to explore new ways of distributing contact hours and developing its resources. In addition, CSS will continue to focus on staff development and in-service training. Of course, the office will continue its policy of reaching out to all segments of the MIT community and pooling efforts with colleagues, providers and educators.

More information on this department can be found on the World Wide Web at http://web.mit.edu/counsel/www/.

Arnold Henderson, Jr.

MIT CARD OFFICE

MIT Card use by students, faculty, employees and affiliates for identification, access, and transacting business campus-wide continued to grow in fiscal year 2000. Some 30,050 new MIT Cards were issued during the year. The total represents 2,150 employee identification cards, 11,790 student cards, 4,990 affiliate cards and 11,120 temporary identification cards. The Card Office staff worked on a daily basis with staff in ODSUE, IS, Facilities, H/R, Libraries, Parking, Campus Police, Medical, MIT labs and departments, Lincoln Lab, software and hardware vendors and other institutions in support of the MIT educational mission.

In June, the MIT Card application was deployed in the Department of Athletics for control of facility access. Daniel Michaud from the Card Office worked hand-in-hand with the Department of Athletics staff to design, develop and implement a new application to improve access security as well as customer service. The newly deployed process allows the Athletics Department to establish and track new Athletics accounts for MIT community members by simply swiping their MIT ID Cards through a custom developed card swipe system. Use of the latest touch-screen technology and seamless integration with the MIT Card Office database allows Athletics employees to determine a community member's status at MIT, create and manage Athletics privileges and accounts and complete customer financial transactions at the touch of a button. A custom MIT Athletics ID badge, jointly designed by both departments, will allow qualified community members without MIT ID cards to make use of Athletics facilities. Planned security enhancements to the current system will tie in with the campus-wide network of card readers thereby ensuring a safer environment. The new system has the added benefit of allowing the Department of Athletics to analyze the demographics of their customer base by drawing upon the information stored within the MIT Card Office database.

Working with our software vendor Imaging Technology Corporation, we increased card production capability by refining the IDCS Database and eliminating unnecessary fields. In addition, indices have been added to the underlying tables to improve response time and reduce disk space requirements. The MIT Personal Data Detail Form we currently use to produce identification cards and underlying tables has been modified to expand the number of clearances possible for each individual and to simplify the presentation of information on the form. A successful migration of the Card Office database to our new SQL 7.0 server was completed. The new server platform makes card production about four times faster than the previous process.

The project to port the MIT Card Office ID Database to Oracle is behind schedule. Once done, we plan to use existing Oracle protocols to securely transmit MIT Card data over the MITNet. This new environment will also support distribution of Card Office image data via the MITNet thus enabling departments and satellite locations to obtain student rosters and employee images on line. Under the successful project management of Shueh- Lin Lee, the Card Office printed and distributed 4,743 paper pages of student roster images in fiscal year 2000. We processed 75,888 individual images to create customer specific roster requests on time.

The Card Office staff successfully met theY2K challenge ensuring uninterrupted campus-wide card service.

Viviane Prodonoff joined the Card Office in August as Student Service Center card support person. Lucy Barrera, Systems Administrator, left MIT and the Card Office in March after 5 years of personal commitment to building the Card Office. The addition of Michael Collins in April has strengthened card operations campus-wide. Turnover creates above average staff replacement difficulty for the Card Office because of the learning curve involved in training new people to use the necessary card production systems and software. Fiscal year 2000 showed us a need to acquire more in house hardware and software integration and trouble-shooting capability and additional budget resources to outsource software support to software support contractors.

More information on this department can be found on the World Wide Web at http://web.mit.edu/mitcard/.

Lawrence E. Maguire

ODSUE INFORMATION TECHNOLOGY

The mission of ODSUE IT is to provide high quality information services support to a wide ranging set of users within ODSUE and MIT. This support focuses on the automation of business processes and information systems to provide students, faculty and administrators with timely and accurate information and support.

Major events in fiscal year 2000 included the successful transition of systems into the Year 2000 and more detailed planning related to the evolution of MIT's Student Information System (SIS) and the organizational realignment of ODSUE.

The first half of fiscal year 2000 was focused on Y2K preparation. Desktop Computing personnel and Analyst/Programmers actively participated in MIT's Y2K planning efforts. ODSUE IT facilitated the Y2K effort for all of ODSUE by educating desktop computer and systems users, implementing changes and extensive application testing to ensure proper Y2K operation. In addition, ODSUE IT actively supported the end of year monitoring and testing effort in anticipation of unforeseen problems. The effort resulted in a computing environment that was fully operational when staff arrived back on campus on January 4, 2000.

Supported by senior management and led by our functional area leaders, we began planning an 18-month effort to evaluate the future direction of the Student Information System. MIT Sloan School's Center for Information Systems Research was engaged to provide planning guidance. The planning effort culminated in a more detailed proposal to undertake a multi-phased project that will include a comprehensive review of SIS system requirements, followed by an in-depth trade study of potential long-term solutions that will result in a decision on which direction to take.

Finally, effective July 1, 2000, the Office of the Dean of Students and Undergraduate Education (ODSUE) will be restructured into two new organizations, the Office of the Dean for Undergraduate Education and the Office of the Dean for Student Life. As part of this restructuring, ODSUE IT has been renamed Student Services Information Technology to recognize the broad responsibility that this office has for supporting student-related technology throughout the entire MIT community.

NEW PROJECTS

In collaboration with our clients the following major projects were completed this year:

Desktop Computer

For the second year, ODSUE has fulfilled its plan to replace 1/3 of all desktop machines on an annual basis. This resulted in deployment of approximately 160 new machines during fiscal year 2000 and redeployment of approximately 50 other machines. This effort, supported by Theresa Regan, MIT Information Systems Director of Office Computing, has been extremely successful and has ensured a robust office-computing environment for ODSUE.

Academic Services

A sophisticated web based application, Who's Teaching What (WTW), was developed and piloted with academic departments to collect instructor information associated with subjects being taught at MIT for a given term. The information collected by WTW feeds the Subject Evaluation project. Additionally, the MIT Provost Office will use the information collected by the WTW process for both internal studies and to respond to outside inquiries.

The Picture Class List pilot designed to make available picture class lists via the Internet to instructors and department administrators was completed this year. Student pictures were also added to the advisor and house master access on WebSIS.

A web site featuring improved advisor access was designed, developed and implemented. MIT student advisors can now access the academic records of their advisees. In addition, they can see their advisee's picture, review pre-registration information, grade reports including completed audit, subjects taken in current term including the projected audit and review individual student schedules.

The WebSIS web site was redesigned to bring together student and academic information for students, faculty, advisors, and departmental administrators.

An analysis of MITSIS data to reside in the MIT data warehouse was completed. The transfer process to move data to theWarehouse was implemented. This analysis and data transfer will continue as new data is collected and needs arise.

Implemented system changes required to support the new graduate student summer tuition policy.

The new centralized academic Curricular Information System (CIS) will support curriculum development, Catalogue publishing and the course information maintenance used in student records. It will also provide the infrastructure to support the eventual development of student portals, facilitating communications among students, teachers, advisors and administrators. Details are available under the project vision and scope: http://web.mit.edu/odsue/odsue-it/cis/CISVisionScope.html. The CIS project began in 2000 with user interviews and documentation of the old catalog proposal systems and manual processes. Requirements for the new system are currently under development.

Design enhancements were made to IAP based on feedback from its introductory year. Chief among the changes: statistics were added to each user's individual proposal home page, one click rollover of prior year subjects, easier-to-use scheduling, easier submission for group-sponsored activities and easier and more flexible downloading. The public IAP Home Page now includes a day-by-day calendar (previously on thesearch page) and a daily featured activity.

Minor programming enhancements were made to the Freshman Essay Evaluation system, now in its third year. One important change enables freshman advisors to access their advisee's essays and grader comments through WebSIS.

Freshmen matriculating in the fall of 2000 entered the HASS-D lottery over the web using the secure web server also used for Freshman Essay Evaluation during the summer.

All undergraduate HASS-D General Institute Requirement's (GIR) have been changed in the audit to comply with the new HASS-D requirements. Upon rerunning all actual audits: 9 seniors, 5 juniors and 1 sophomore gained one subject toward their HASS-D GIR.

In addition, we enhanced an existing report to facilitate the Course 6 MEng audit, and we researched methods for implementing the new Communications Initiative.

Student Financial Services

Functionality was developed to produce student collection letters. The first mailing resulted in an influx of $10K to $20K in revenue. In addition to the revenue collected, a number of delinquent students established contact with their respective Account Representatives to discuss their account status.

The process for archiving student account transactional data was developed and implemented. Its implementation improved performance when closing Student Cashiering Sessions at the end of the day and when processing the Student Monthly Bill/Statement.

The federal government requires a notification to be sent every time a Title IV Fund is disbursed. MIT was one of the first schools to implement an electronic notification process.

ODSUE IT collaborated with Data Warehouse group to move Financial Aid data (including awards, loans, disbursement, need analysis, requirement tracking, budgeting, MIT grant, Student Payroll distribution and Student enrollment information) to Data Warehouse. This project provides SFS users with a flexible and easy-to-use reporting environment to meet their internal and external (departments, outside agencies, MIT management) regular or ad hoc reporting needs. Regularly requested reports were established for the convenience of SFS.

In collaboration with Impromptu, ODSUE IT implemented a system to enable MIT applicants to check the status of their financial aid applications via web. This process is integrated to MIT Admission Applications Tracking system to give MIT applicants a single online location to check all of their application components.

SIS changes were implemented to comply with changes in federal law, also adding audit functionality to Direct Loan creation and disbursement process.

After a loan note signing period, loan services users need to update the status for a large number of loan notes. A new form was designed, developed and implemented to allow users to update student loan status in more of a data-entry mode that allows fast input of data with fewer keystrokes.

The technology and support for MIT's Need Analysis process was reevaluated. The PowerFaids product from CollegeBoard is being considered. This project will continue into the coming year.

A project to integrate international student information into the Student Information System on a secure platform, thereby providing flexibility to meet future changes in federal law was begun. The discovery phase of this project was completed this year. Implementation will take place in fiscal year 2001.

GENERAL

Numerous database and process modeling tools were investigated to improve efficiency in documenting old and designing new ODSUE IT systems. The SilverRun Business Process Modeling and Relational Data Modeling Tools were chosen for best all round utility.

An effort was begun to upgrade our systems through the migration of the Student Information Systems to a more technologically advanced platform. This will result in a more easily maintainable system with a greater potential to support the anticipated growth in data, functionality and user community.

An effort to develop a Java based infrastructure has been underway during this past year. This technology will allow ODSUE IT to develop more robust, web based applications to meet the needs and demands of complex business processes and a sophisticated client base (including students, faculty and administrators).

The MITSIS Database was extended to provide secure, real-time connections with the MIT Data Warehouse, MIT Roles Database and EECS Student System Database. This will provide faculty and administrators with more accurate and timely access to student data.

FUTURE PLANS

With approval and funding from senior management, it is expected that we will complete the analysis of requirements (including determination of scope) for the evolving Student Information Systems. Next year we will begin the comparative analysis of potential long-term solutions.

Our current organizational model for application systems provides for teams to support different administrative areas. Each team has pre-assigned resources, adjusted as program priorities change. With the organizational structure of ODSUE changing, ODSUE IT will be revisiting the internal structure in place to support student services departments.

PERSONNEL CHANGES

In fiscal year 2000 we completed the planning and received funding to implement our consultant migration plan. During fiscal year 2001, we will be migrating away from the use of contract analyst/programmers to support ongoing work and instead will supplement our staff by hiring regular MIT employees. This presents a significant challenge, as the market for information technology professionals remains limited.

In December of 1999, Tony Porter resigned to pursue a position outside of MIT. His appointment at the time was a temporary position. In May of 2000, the two technical assistant positions were changed from temporary to regular appointments. Also, at that time, Joseph Welch was hired as a Senior Technical Assistant.

The Student Financial Services Teams had a challenging year with staff losses within ODSUE IT (MIT Analyst/ Programmer Alice Cavallo and contract programmer Leo Larson) along with losses of key administrative staff in the Office of Student Financial Services. Support and development was successfully provided by the extra efforts of the current staff. Joining the SFS teams were Tom Wanderer (mid-year) and Joseph Greene (May). Both bring their several years of technical experience and human relationship skills to the support of current and future systems.

More information about this department can be found on the World Wide Web at http://web.mit.edu/odsue/odsue-it/.

Robert A. Rippcondi

OFFICE OF ACADEMIC SERVICES

THE ACADEMIC RESOURCE CENTER

This area of the office includes many of the principal non-departmental academic resources for students and their advisors. The ARC places particular emphasis on freshman-focused services and activities, having responsibility for new-student orientation, freshman advising recruitment, training and management and freshman-year programming in general. ARC staff are involved in the work with many colleagues and Institute committees and in the past year have participated in three parents' panels during Orientation, Family Weekend and the Campus Preview Weekend. ARC also held a successful Orientation Parents' Open House attended by approximately 100 parents. ARC staff served as members of the Committee on Undergraduate Admissions and Financial Aid (CUAFA) and appeared before the Committee on Undergraduate Program (CUP) Subcommittee on Pass/No Record grading. The office that supports the Writing Requirement was moved from Academic Services to the Program in Writing and Humanistic Studies in the School of Humanities, Arts, and Social Sciences.

FRESHMAN ADVISING

The Class of 2003 was advised primarily through the Freshman Advising Seminar (FAS) system. The number of FASes declined again this year from 130 to 101. The 197 freshman advisors for 1999–2000 included 116 Freshman Advising Seminar leaders and 81 "traditional" advisors. The advising cadre included 84 faculty, 14 lecturers, four teaching staff, one adjunct professor, one visiting professor, one medical doctor, ten research scientists, five graduate students, 74 administrators and three other staff members. One or more Associate Advisors assisted most advisors.

Recruitment of both FAS and "traditional" advisors from faculty ranks remains a serious issue. Demands on faculty time seem to be increasing. It is frustrating for this staff to hear young faculty express not only the wish to participate in freshman advising but also the impossibility of being able to take on the task.

Plans are underway to pilot a residence-based advising program in the coming Fall Term. The new McCormick advising program—organized by staff in Academic Services and joined by staff in Residential Life and Student Life Programs—will assign all freshmen in that residence hall to either seminar-based or regular advising groups.

There were 220 active Associate Advisors for the academic year. The Associate Advising Steering Committee offered new programming including new Orientation training, a suicide discussion, 10 study skill programs, 2 FSILG presentations on academic survival and 8 IAP related programs. The Associates also created a new series called "How To" that incorporated suggestions for approaching professors, navigating academic forms and when and how to find help. The ever-popular Choice of Majors Fair was held during IAP and again in late March.

Approximately 60 advisors attended two advisor workshops sponsored by the ARC during the Fall Term. Four dinners held during the Spring Term, to recognize advisors and launch the recruitment program for the forthcoming year, continue to provide a useful and sociable forum for advisors, faculty and staff.

Of the 264 freshmen eligible for sophomore status at the end of the Fall Term, only 25 students accepted it.

ORIENTATION

Orientation '99 was an opportunity to improve on the new programs of the previous year. The schedule continued to highlight the following programs: the faculty Welcome Dinner (moved to the second night after students arrived); involvement of upperclass students as Orientation Leaders; three existing pre-orientation programs involving academics, community service and leadership; and the Residence Midway that allowed students to investigate housing options without leaving campus.

New programs included a presentation by Jay Friedman regarding alcohol and relationships; a health and wellness fair involving athletics; a presentation on the history of hacks and the tradition of the Brass Rat; programs focusing on women's and LBGT issues; and two new pre-orientation programs that involved arts and an outdoor experience. The Orientation Committee was comprised of four full-time student interns and 25 volunteers.

ARC PROGRAMMING AND OUTREACH

All publications prepared by the ARC are now available on the Web, and we are continuing to increase our visibility and use of the Web to provide information to students and their advisors. Given the academic focus of the Academic Resource Center, our outreach efforts tend primarily to programming such as study skills and choice of major

workshops. This year we introduced a number of activities designed to promote interactions between faculty, staff and students. Recent activities include the following:

- A series of new programs held in the recently renovated Baker Residence was implemented. "Tuesday Nights at Baker" offered 12 program nights during the Fall Term and 8 in the Spring Term. The ARC coordinated this effort and led five of the 20 programs. ODSUE staff from a number of other areas led programs covering a variety of topics.
- The Associate Advisor Steering Committee held three test review sessions each semester as well as several time management and study skills sessions throughout the year. Study skills sessions also took place at Burton-Conner and at a meeting of the Society of Hispanic Professional Engineers.
- A guide to "Choosing a Major" was introduced this year as part of a cooperative effort by the Student Committee on Educational Policy and Academic Services. Sarah McDougal, '00, who served as an intern in our office, was editor of the guide.
- A series of freshmen-faculty lunches, co-sponsored by Academic Services and the Campus Activities Complex, was held in the Spring Term to promote discussions about academic choices.
- "How to Get There from Here" consisted of two panel discussions on choosing majors and the connections, if any, between majors and eventual career choices. This program was co-sponsored by the Office of Career Services and Preprofessional Advising, the ARC, and featured the participation of recent alumni/ae.
- We continue to administer three fellowship programs: the Kawamura Fellowship (Krishna Sanka, '00, was a winner); the Beinecke Scholarship for Graduate Study in the Humanities, Arts, and Social Sciences (MIT had one finalist); and the Morris Udall Scholarship.

TRANSFER STUDENTS

Thirty-five transfer students, including 10 international students, enrolled in the Fall of 1999. This is the largest number of transfers in recent years (up 75% from last year). In addition, for the first time in many years, transfer students were not guaranteed on-campus housing (only nine students received on-campus housing). Transfers chose majors in 12 different departments, with approximately one-third of these students selecting Electrical Engineering and Computer Science. Two transfer students enrolled in the Spring Term.

INDEPENDENT ACTIVITIES PERIOD

During IAP 2000, the MIT community had a choice of nearly 600 different activities. There was a slight rise in the number of for-credit offerings this year (up to 102 from 92) that may be explained by the ease with which departmental administrators are now able to post their subject offerings. The user-friendly on-line submission form and the IAP on-line Guide at http://web.mit.edu/iap/ are in their second year. Because the Web site is so easily accessible to MIT students, faculty and staff wanting to submit activities, as well those wanting to peruse them on-line, the IAP office intends to print and distribute fewer hard copies of the *IAP Guide*.

In a continuing effort to encourage active faculty/student interactions, Academic Services sponsored the "IAP Spark Forum," a series of ten lectures designed to showcase the exciting interdisciplinary research of young MIT faculty. These talks were organized by Professor David Mindell, faculty chair of the IAP '00 and Dibner Assistant Professor of the History of Manufacturing and Technology, and Ms. Van Chu, Academic Services staff member. An average of 50 undergraduate and graduate students attended these talks. A small pre-selected group went to dinner after each lecture with the faculty member and her/his graduate students to continue the conversation.

The IAP Millennium Ball—also initiated by Professor Mindell— on January 29 marked the turn of the new century and was attended by more than 2,500 students, faculty and administrators.

SUPPORT TO THE COMMITTEE ON ACADEMIC PERFORMANCE

We are pleased to note that more students are making use of the CAP web page for information and petitions. There was also a noticeable increase in the number of email messages sent to "cap-help@mit."

Table 1. The following is a recap of CAP and ARC Actions for freshmen over the past five years:

Academic Year	Required Withdrawals	CAP Warnings	ARC Letters	Total Academic Actions
1999-2000	5	133	113	251
1998-1999	6	158	89	253
1997-1998	5	175	146	326
1996-1997	16	196	99	311
1995-1996	10	202	110	322

UNDERGRADUATE RESEARCH OPPORTUNITIES PROGRAM

This past year UROP marked its thirtieth anniversary with a celebration in Lobby 7 on February 3, 2000, the day before the Institute's MacVicar Day honoring Margaret MacVicar's commitment to education. Faculty, students and staff attended the celebration, which featured speeches by Professor Paul Gray and Dean Rosalind Williams as well as music by Professor Samuel Keyser and his band. UROP also hosted a special web retrospective of UROP's thirty years at MIT, and articles recognizing this milestone appeared in *Tech Talk* and the *Tech Review*.

During summer 1999 and academic year 1999–2000, a total of 1,758 students conducted 2,819 UROP projects. This total represents a decrease in UROP participation from academic year 1998–1999 and summer 1998, when a total of 1,833 students participated in 2,982 projects. One reason for this drop in participation may be that students facing self-help demands are choosing to accept non-Institute employment (particularly with software and web-based technologies) that pays significantly more than MIT-based positions. Another reason might be that students wishing to avoid UROP paperwork are opting to set up their paid research positions directly through the student employment office, which does not require a research proposal or project evaluation.

Student financial obligations may also explain the increasing preference for earning pay rather than credit for UROP work. In AY 1999–2000, 68% chose UROP for pay and 31% chose UROP for credit, while in AY 1998–1999, 64% chose pay and 35% chose credit. During the summer, almost all UROP students conduct their projects for pay. With one or two exceptions, students will not choose credit as an option. Aside from the need for summer income, students cannot or do not wish to pay the tuition fees normally charged for taking UROP for credit over the summer.

Over the past academic year, UROP strengthened ties with key staff members in Resource Development. At the end of the year, UROP's endowment totals over $7 Million (excluding funds managed by academic departments). The goal of the MIT capital campaign is to increase UROP endowment to $15 Million. Increased income from endowment combined with gifts and Institute funds has allowed the UROP Office to disburse $950,000 in student support over the most recent funding cycle (fall 1999, spring and summer 2000), exceeding the amount provided during the previous funding cycle by over $200,000.

UROP's IAP Research Mentor Program once again proved to be a highly effective method for preparing freshmen for UROPs. One participant commented: "...the pre-UROP program was a wonderful experience for me. I think it is an excellent way to introduce us to research at MIT." Throughout the four-week program, experienced UROPers provided guidance to beginners while working on their ongoing UROP projects. This year nearly 40 mentors collaborated with 61 "pre-UROPers." Fifty-five per cent of this year's participants went on to their own UROPs during Spring and Summer 2000.

This year, the UROP Office was very pleased to hear from two alumni who had participated in the UROP. In January, we received a call from a 1996 graduate in EECS who had recently sold his very successful company. Because he felt that his UROP experiences played a key part in his success, he indicated to UROP staff that he would like to take proceeds from the sale and make a gift to UROP. His intention is to donate $1 Million. In addition, John Grunsfeld '80, a graduate in Physics and one of the NASA astronauts who participated in the space shuttle mission to repair the Hubble telescope, contacted UROP. Dr. Grunsfeld presented the UROP Office with a framed collection of MIT memorabilia that he took with him in space. Included in this collection was an inscription thanking UROP for helping "current and future astronauts prepare for science and engineering research in space."

CURRICULUM DEVELOPMENT AND FACULTY SUPPORT

Academic Information and Communication

This area continued its work to provide students, faculty, and staff with accurate and accessible information on academic opportunities, policies, and procedures. Almost all of its efforts are the result of collaborations with other staff both from within and outside Academic Services. Recent activities include:

- Securing a d'Arbeloff grant to develop a strategic plan for providing on-line information for advisors and freshman, and holding beginning discussions on format and scope of project. With staff from the Academic Resource Center developing a "firstyear" web site with initial information for incoming students. The site will be expanded in the coming year in conjunction with pilots to improve information on study skills and choices in the second semester.
- Expanding WebSIS from a web site for students to access their own records to a site where instructors, advisors and departmental administrators may also access information about their students. The site also organizes academic information for students, instructors and advisors. The new site, the result of the efforts of a team including staff from the Registrar's Office, ODSUE IT and Student Financial Services, debuted in January.

- Revising the report of the Faculty Policy Committee's Subcommittee on Examination and Term Regulations, and writing and editing of motion to the Faculty to revise regulations on undergraduate subjects. Upon Faculty's approval of new regulations, updating publications to reflect new policies.
- Expanding the Choice of Major site to include departmental information collected under a joint project of the Student Committee on Educational Policy and Academic Services.
- Updating web pages on the Undergraduate Program, including descriptions and charts of Institute and departmental requirements and options for minors. The information for these pages comes from the MIT Bulletin. Consulting with members of the Communications Office as they first published the Bulletin on line this year. Revising printed Registration Instructions/Class Schedules book and publication of information on the web.
- Updating for Registrar's Office of web sites on graduation, tuition, enrollment statistics, the academic calendar, transcripts and forms.
- Updating and editing copy for the Student Handbook, *How to Get Around MIT*, which is published in August by the offices of Academic Services and of Residential Life and Student Life Programs.
- Consulting with Communications Office and Graduate Students Office about improvement of information for graduate students, and with Human Resources staff on development of umbrella web site on Work and Life at MIT.

Classroom Management and Scheduling

The Classroom Management and Schedules Office spearheaded a major effort with faculty, Academic Computing, Facilities, Audio/Visual Services and the Planning Office to renovate three small classrooms in Building 1. In addition, a major training partnership with Audio/Visual Services continued to provide training sessions each term to outline the teaching possibilities in the technologically-equipped rooms. Some other key projects included:

- Major technology upgrades to classrooms 2-105, 6-120, 14E-310, 26-100 and 34-101 to support course-driven computer and technology needs.
- Fixed seating replacement in 4-163, a major lecture hall.
- Refurbished wood paneling and interior finishes in five lecture halls.
- Continued ongoing classroom furniture replacement program.
- Developed and implemented faculty classroom survey.
- Developed and distributed Schedules Office Calendar and Classroom Audio/Visual Equipment chart to enhance communication and planning for the academic departments.
- Provided various room utilization reports to the Planning Office and freshman scheduling data to support d'Arbeloff pilot.

Educational Research

Educational Research designs and administers studies about important curricular and co-curricular issues for the purpose of providing faculty and administrators with information about the undergraduate student body to help guide policy development and decision-making. This year we engaged in a variety of research projects: large- and small-scale surveys, assessment projects, focused interview studies and database mining projects.

Surveys

We administered our own in-house survey of the freshman year experience to early first semester sophomores. This survey is conducted at four-year intervals. The first such survey was conducted for freshman year '94–'95. This winter, in conjunction with the Alumni Association and the Office of the Provost, we participated in a COFHE (Consortium on the Financing of Higher Education) Alumni Survey and surveyed the classes of '79, '84, '89, and '94. The Boston Coalition, a group of universities and colleges concerned about the use of alcohol and drugs among the student population, asked its member schools to administer the CORE Alcohol and Other Drug Use Survey. In conjunction with the Medical Department, we administered this survey to a random sample of 1,000 undergraduates during the spring semester. We also administered the Educational Benchmarking, Inc. (EBI) Survey of Engineering Seniors for the School of Engineering in preparation for the 2001 ABET Accreditation Review. We assisted a number of departments with their 2000 Senior Exit Surveys. Each year around graduation time, Career Services administers a survey to all graduating students (undergraduates and graduate students). Our office assisted Career Services by analyzing the data and disseminating reports and information.

Assessments

We assisted the Center for Advanced Educational Services (CAES) by assessing the usefulness of PIVoT, a newly created Web-based supplement for 8.01. During this past year, the Web site was still being developed and improved. The final version will be ready this coming fall. Last summer we conducted a formative assessment of PIVoT usage

by MITES students. This past fall, we conducted a formative and summative assessment of PIVoT usage by 8.01 students who were enrolled in mainstream physics. During the spring we administered a survey about PIVoT and CyberTutor to students who were enrolled in 8.01. As we have done each summer for many years, we gave Interphase students two self-assessment questionnaires (mid-program and at the end) to target the strengths and weaknesses of the summer experience.

Focused Interviews
We conducted interviews with course 13 undergraduates to learn about the factors influencing their choice of major. Since many course 13 students had considered majoring in course 2, we selected a random sample of course 2 students as a comparison group.

Data Mining Projects
In conjunction with the Admissions Office, we conducted a study for Committee on Academic Performance (CAP) to examine a cohort of students who entered MIT in 1992 to see whether having academic difficulties in the first year has an impact on undergraduate cumulative grade point averages (GPAs) and graduation rates. Using data from the 1998 Senior Survey, we engaged in an exploratory study to understand why minority student participation in UROP is lower than would be expected based on the size of the minority population.

Educational Studies Working Group (ESWG)
Our office continued to convene ESWG, a group of administrators who either conduct student-related research or have an interest in this area. Our monthly or semi-monthly meetings provide an opportunity for colleagues around the Institute to share research results and insights.

Subject Evaluation
Since 1995, the Office of Academic Services has been responsible for end-of-term subject evaluation. Until the spring of 1999, we had been contracting an outside company to scan and analyze evaluation forms and produce reports. In the spring of 1999 we implemented an in-house process that is faster, more reliable and specifically tailored to MIT needs. We also introduced new evaluation forms - one for Science/Engineering subjects and one for Humanities, Arts, and Social Sciences subjects - with new questions about the use of information technology and the number of hours spent in class and on homework. The new evaluation forms also allow departments to include questions specific to an evaluated subject. Departments and Schools receive their reports within three to four weeks of the end of term. In the Spring Term, 653 MIT subjects (378 Science/Engineering and 275 HASS subjects) were involved in the subject evaluation process, representing all academic departments except Courses 6 and 15. An MIT-only web site (http://tute.mit.edu:8001/acadinfo/sse/) has been developed, containing all statistical data from both Fall and Spring Term evaluations. We are working with the School of Engineering to tailor the evaluation form to be more useful for assessing students' perception of what they learned in specific subjects. We are expanding the "subject specific" portion of the evaluation form, which will likely result in an increased workload for the staff who support the process.

Who's Teaching What
The WTW is designed to improve how MIT collects data about individuals involved in the teaching program. The primary goal of the pilot efforts underway over the last year has been to develop a user-friendly, automated process to collect instructor information from academic departments. This collaborative effort between Academic Services and ODSUE IT was motivated by the need to respond to the increasing requests for information about who is teaching our students. Five departments served as pilot sites during the Fall Term of 1999; they worked with developers and tested the input screens. Six additional departments joined the pilot during the Spring Term. The goal is to involve all departments in this process in the 2000–2001 academic year.

D'ARBELOFF EDUCATIONAL GRANTS
The Council on Educational Technology and its Grants Subcommittee issued a call to faculty for proposals for innovative and ambitious educational projects that would enhance and potentially transform dramatically the first year experience of our students. This office provided considerable support throughout the entire process – from the drafting of the original Request for Proposals and overseeing the proposal review process, to managing the budget disbursements to the seven projects that have been funded for the 2000-2001 academic year. In addition, we were involved in the development of the first year advising proposal and continue to work with individual faculty who are undertaking pilot projects next year.

TEACHING AND LEARNING LABORATORY

With the launch of the I-Campus and d'Arbeloff initiatives, the past year has seen heightened activity in the area of educational innovation at MIT. The Teaching and Learning Laboratory has been involved in several aspects of the overall administration of I-Campus, as well as with a number of individual projects. (TLL's Director is a member of the Council on Educational Technology and co-chairs the Assessment/ Learning subcommittee). In addition, TLL has: served as host to a number of international visitors who have been interested in learning more about MIT's educational efforts; begun a research effort tentatively titled the "Project on Interdisciplinarity"; and maintained its stable of ongoing programs.

Involvement with I-Campus and d'Arbeloff Initiatives

TLL was asked to contribute to the system-wide organization and administration of the I-Campus initiatives in several ways. We coordinated the effort to create and evaluate an initial assessment plan that was submitted by each of the I-Campus finalists. We also designed and co-facilitated the first of a series of seminars for the I-Campus and d'Arbeloff PI's. Now named the "Educational Change Seminars," this series will continue throughout the next year. We serve on an ad hoc committee that will arrange to bring a number of U.S. and international experts in education to MIT to speak on issues of importance to the I-Campus and d'Arbeloff initiatives.

Table 2. Individual projects Receiving Consultation from ODSUE IT

PROJECT	P.I.	CONSULTATION
"Engineering Education in an IT Environment"	M. Boyce	Review of proposal; assessment
"A School-wide Modular Program for Fluid Mechanics"	C. Mei	Review of proposal; learning styles; assessment
"Technology-Enabled Active Learning (TEAL) at MIT"	J. Belcher	Development of learning objectives; collaborative learning
"New Communication Links for Freshmen-Sophomore Mathematics"	D. Jerison	Review of proposal
"Active Learning Enabled by Information Technology"	D. Newman	Consultation done as part of Course 16 Teaching Team

In addition, we continue to be part of the on-going team that advises the TEAL effort and will help design and lead workshops on teamwork skills for the Mission 2004 undergraduate facilitators as well as the freshmen enrolled in the course.

Scholarship

With Donna Qualters, Director of the Teaching Effectiveness Center at Northeastern University, we are embarking on a research project to study interdisciplinary education. This project is based on a request from Professor Martha Gray to explore one of the strengths of HST—the enrollment of Ph.D. students and medical students in the same program—to see if that coupling might be made even stronger. Our working hypothesis is that when working together, faculty and students from different disciplines are, in effect, engaging in a kind of intercultural communication: that is, they talk a different language, have different norms and values, use different tools, have different expectations for success, etc. We believe interdisciplinary work can be improved by understanding those differences and providing teachers, students and researchers with the means to "communicate" across "cultures." Although we will be working with HST initially as a case study, we believe this work will have implications for many other efforts at MIT and for higher education.

Finally, this year, our article, "Educating the 'Larger Life,'" was published as a chapter in *The Reflective Spin: Case Studies of Teachers in Higher Education Transforming Action* edited by Ai-Yen Chen and John Van Maanen.

International Outreach

TLL hosted several faculty and student groups who were interested in learning more about MIT's efforts to improve teaching and learning. These visitors came from Lebanon, Singapore, the Netherlands and Thailand. In addition, we went to the University of Cambridge as part of the Cambridge-MIT Institute to meet our counterparts in faculty development at that university. As a result of that visit, a recommendation has been made jointly with Richard Wakeford, Cambridge Staff Development Officer, to create workshops for both faculty and students who will be involved in exchanges. The objective of those workshops will be to help make the transition to the new institution easier.

On-Going Efforts

This year, responsibility for the organization of the New Faculty Orientation, which had been a TLL project, was transferred to the Provost's Office. However, TLL maintains the remainder of the activities and programs it has developed over the last three years. These include:

- *Classroom Videotaping and Consulting Program*—approximately 75 tapings and consultations were done this year both in the Kaufman Classroom and in the field.
- *The MIT Electronic Forum on Educational Innovation*—the Forum now has over 50 entries. It serves as a resource for those who are involved in educational experimentation at the Institute.
- *Redesigned website*—the new TLL website is more attractive and easier to navigate; information on the website has also been updated.
- *Orientation for New Graduate Teaching Staff*—TLL continued to partner with the Graduate Students Office on this one-day workshop. Last year's attendance was approximately 125.
- *Microteaching*—we participated in the math department's twice annual microteaching workshop for all graduate and undergraduate TAs.
- *The "TeachTalk"* column in the Faculty Newsletter contained a four-part series on interactive teaching.
- *"Better Teaching @ MIT"*—our annual IAP series included workshops on active learning, using educational technology and effective course administration. Approximately, 125 people attended the six workshops.
- *Workshops*—We developed and/or facilitated workshops for: Course 16, STS, Course 9, the GSO Professional Development Series, MIT Summer Research Program and the Library Staff.

REGISTRAR'S OFFICE

We continue to partner with ODSUE IT to develop technology to expand our delivery of information and services. Key activities this year included development and implementation of:

- A new functionality whereby faculty and academic administrators can obtain an online picture class list of students enrolled in subject. We are utilizing this same functionality to provide advisors online photos of their advisees.
- An unofficial transcript for students.
- A degree audit report for Course 6.
- A new enrollment statistics web site.
- A fair, but aggressive, means of assessing late student fines.
- A business model for the replacement and upgrading of technology enhanced classrooms (in collaboration with Audio Visual Services and Academic Computing).
- Changes to MITSIS to support the revised summer session subsidization tuition policy for graduate students (in collaboration with ODSUE IT and Student Financial Services).

In addition, we worked with Information Services, House masters, and the office of the Dean of the School of Science to improve how online information is tracked and delivered.

In other areas:

- The Working Group on Student Information Policy successfully developed and received approval for a new Student Information Policy for the Institute.
- We eliminated several traditional mailings and replaced them with electronic mailings directing students to WebSIS.
- We implemented a number of faculty committee policies as directed by Faculty vote, including the new CoC policy limiting the number of SB degrees; the new evening exam and end of term policies; and the new HASS Distribution Requirement policy.

Finally, we responded to an ever-increasing volume of data requests pertaining to student performance and class enrollment.

Registration

In 1999–2000 student enrollment was 9,972, compared with 9,885 in 1998–99. There were 4,300 undergraduates (4,372 the previous year) and 5,672 graduate students (5,513 the previous year). The international student population was 2,386, representing 8% of the undergraduate and 36% of the graduate populations. These students were citizens of 105 countries. (Students with permanent residence status are included with US citizens.)

In 1999–2000, there were 3,287 women students (1,768 undergraduate and 1,519 graduate), compared with 3,202 (1,776 undergraduate and 1,426 graduate) in 1998–99. In September 1999, 452 first-year women entered MIT, representing 43% of the freshman class of 1,055 students.

In 1999–2000, there were, as self-reported by students, 2,669 minority students (1,996 undergraduate and 673 graduate), compared with 2,600 (2,009 undergraduate and 591 graduate) in 1998–99. Minority students included 370 African Americans (non-Hispanic), 93 Native Americans, 554 Hispanic Americans and 1,652 Asian Americans. The first-year class entering in September 1999 included 494 minority students, representing 47% of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1999-2000 included 1,253 bachelor's degrees, 1,457 master's degrees, 14 engineer's degrees and 475 doctoral degrees—a total of 3,199 (compared with 3,196 in 1998–99).

PERSONNEL CHANGES

Michael Bergren was promoted to Assistant Director of UROP, and Elizabeth Cogliano Young was promoted to Assistant Dean for Student Academic Programs.

New staff in the office include Professor J. Kim Vandiver, Director of UROP and Dean for Undergraduate Research; Karen Blose, Administrative Assistant for the Academic Resource Center; and Pauline Blair, Administrative Assistant in the Registrar's Office.

A number of OAS staff departed for new positions within MIT. Kathleen Connolly left her position to return to the Sloan School of Management. Laurie Ward is now a staff member in Residential Life and Student Life Programs. Joseph Gottinger is now employed by Information Services; and Marsha Orent has a position in the Provost's Office. Professor Kip Hodges resigned his position as Dean for Undergraduate Curriculum and returned to teaching and research in EAPS. Because of the transfer of the Writing Requirement office to the Program in Writing, Leslie Perelman and Madeline Brown are now included on the staff of the School of Humanities, Arts, and Social Sciences.

Finally, this year saw the retirement of Bonnie Walters as Associate Dean for Freshman Advising. She will be missed by many.

More information on this department can be found on the World Wide Web at http://web.mit.edu/odsue/academic/.

Margaret Enders and Mary Callahan

OFFICE OF CAREER SERVICES AND PREPROFESSIONAL ADVISING

The Office of Career Services and Preprofessional Advising's (OCSPA) mission is to help students learn about the relationship between what they do at MIT and life after graduation, to develop the competencies required beyond technical knowledge, to make informed decisions about career goals and find opportunities related to their professional objectives and to contribute to civilization.

OCSPA's philosophy is that career development is an ongoing process that includes: self-assessment, career exploration, choice of major, competency development; and preparation for the job search or graduate/professional school application process and productive, rewarding lives. Above all else, it is a generative process, which provides a foundation for achieving goals throughout life. Students are encouraged to begin their career education early, including a visit to OCSPA during the freshman year or the first year of graduate school, to learn what career resources are available.

In striving to provide better service to MIT students, employers, alumni, faculty and other administrators, Career Services and Preprofessional Advising seeks to contribute to a dialogue about Institute-wide learning. Our academic role at MIT is to build and maintain enabling systems, which encourage us as a community, and especially our students, to become self-managed learners who can contribute to learning organizations where we work and live. OCSPA assists students as they explore career options in relation to choice of major; understand the competencies required beyond their technical knowledge to succeed in the competitive global marketplace, and contribute to civilization; identify networking, informational interviewing, mentoring, internships, summer jobs and other opportunities to gain experience in fields of interest; apply to medical, law or other graduate/professional school; study abroad; write resumes and conduct interviews; and find employment after graduation.

Employers, like society at large, hire and promote on the basis of competencies, not majors. The required competencies get the job, but these competencies are not major dependent. In addition to technical knowledge, the desired competencies are: effective communication, critical thinking, team building, information technology, managing change, leadership, diversity, social responsibility and self-managed learning. It is important to ask what are other or will be new competencies that civilization will require of us.

OCSPA's efforts to focus on generative learning are intended to help us, both ask that question and find shared answers. While we have accomplished many objectives in this past year, addressing new services to students and employers, including demand from students for major specific employment recruiting and employers, equipment and staffing, OCSPA continues to have serious needs in terms of facilities and location.

MAJOR ACCOMPLISHMENTS

OCSPA seeks explicit collaboration with the academic departments, especially through Deans, Department Heads, and other faculty, as a way to achieve our goal of providing effective career services to our students. Since September 1998 we have been organized in School-based teams. These teams have enabled us to strengthen our services to each School and Department, and to better serve students at all degree levels and in all disciplines.

In addition several key initiatives affect our services in significant ways:

- Initiating programs that contribute to students' learning including the development of competencies required to contribute to society in the 21st century;
- Providing career development to students beginning with freshmen and first-year graduate students through a programmatic sequence of workshops and seminars;
- Continued expansion of information technology to better serve students, alumni and employers with direct access to our new web-based employment recruiting system, 7 days a week and 24 hours a day;
- Gathering data from 45% of the 2000 graduates on their post-graduation study or employment destinations.

OCSPA staff have also met with deans and department heads, and with many academic administrators and faculty in departments to offer and provide help in a variety of ways including: participating in events for prospective, incoming, and current students; developing of career information for their departmental websites; collaborating on developing internship and other programs which provide professional opportunities to their students; and providing information about the post-graduation destinations of each School or department's graduates.

The department has created a menu of six career development and two premedical advising workshops offered on a recurring schedule in settings across campus including FS/ILGs and for various groups of students. The capacity of the OCSPA website is also being expanded to incorporate interactive sections that encourage and support student learning. All of these workshops are now also available to students on the web, and as a result, 7/24.

During 1999–2000 the OCSPA staff maintained high levels of career development service to students including more than 1,624 individual career development counseling appointments, 85 career development workshops attended by 619 students, plus 6 workshops targeted to and attended by 182 graduate students, and more than 81 special presentations attended by more than 2,192 students. Students from all the schools, all years in school and all degree levels participated. The following tables detail this level of activity and identify which MIT students are utilizing our services. All tables cover the period September 1999–June 2000.

Table 3. Individual Career Development Counseling Appointments by School

School of Science	429
School of Engineering	764
School of Architecture and Planning	104
School of Humanities and Social Science	53
School of Management	230
Undeclared and Freshmen	44
Total	1,624

From September 1999–June 2000, students coming in during "Walk-In Hours" totaled more than 672.

During 1999–2000 we added "Mock Interviews" (30-minute one-on-one sessions where students met with a Career Assistant) to our services and conducted 58 mock interviews.

Total individual counseling sessions (1,624) was 20% lower than last year (2,032). However, the total number of walk-in visits increased by 76% over last year. In addition, OCSPA provided some new services including basic workshops targeted specifically for graduate students, as well as an increased number of workshops tailored to students in specific departments.

Table 4. Menu of Career Development Workshops Delivered

1 – Get a Job! Introduction to OCSPA services and on-line recruiting system	11
2 – Finding a Place to Start: Step One in the Career Planning Process	8
3 – Smart Resumes, Cover Letter, and CVs	20
4 – Winning Interview Techniques	21
5 – Navigating the Job and Interview Market: Effective Search Strategies	8
6 – Competencies That Build Leaders in the New Millennium	8
7 – Successfully Evaluating and Negotiating Your Job Offers	3
8 – Networking 101	3
9 – Medical School Essay Writing	3
Total	85

Table 5. Workshop Registration by Class Standing

Undergraduate	173
Graduate	181
Post-Doc	24
Alumni	12
Other	1
Not Specified	228
Total	619

Table 6. Workshop Registration by School

School of Science	126
School of Engineering	187
School of Architecture and Planning	55
School of Humanities and Social Science	11
Sloan School of Management	12
Whitaker College of Health Science and Technology	3
Not Specified (during IAP pre-registration was not required)	225
Total	619

The total attendance at our basic workshops (619) was 61% lower than the previous year. However, all of our basic workshops are available on our web site. In addition, the attendance at our special presentations and our basic workshops for graduate students combined (2,554) was over 85% higher than the previous year.

A total of 205 graduate students and postdocs and 173 undergraduates attended our basic workshops in 1999–2000. We also continued to offer popular workshops on topics such as Interviewing, and Evaluating and Negotiating Job Offers to heterogeneous groups of undergraduates and graduates, while providing self-assessment and resume writing workshops specifically for graduate students. The trend for more graduate students and postdocs (combined) at our basic workshops (outlined above) has continued despite the addition of new workshops specifically targeted to graduate students. This may reflect the greater flexibility that graduate students and postdocs have in their schedules, allowing them to attend more workshops.

The basic workshops itemized below were offered especially for graduate students during the 1999–2000 academic year.

Table 7. Menu of Career Development Workshops

Name	Sessions	Number Attended
Especially for Graduate Students*	2	57
Finding a Place to Start: Step One in the Career Planning Process	4	125
Effective Resumes, Cover Letters, and CVs	6	182

*Also see MIT-Wide Presentations (Several targeted specifically to PhDs)

Table 8. Special Presentations

MIT-Wide	475
For School of Science Departments	72
For School of Engineering Departments	374
For School of Architecture and Planning Departments	385
For School of Humanities and Social Science Departments	37
Sloan School of Management Department Presentations	40
Total	1,383

MIT-Wide Presentations

Presentation to parents at Family Weekend (Oct. '99)	250
IAP 5 Alumni Panels for PhDs [special programs for graduate students]	315
Corporate Etiquette Seminar and Reception	72
IAP Stress Management Workshop	5
IAP Mock Interviewing Workshop with Employers	20
IAP Program on Public Service	12
IAP Program on Study Abroad	30
IAP "How to Get There from MIT"	50
Freshmen Interested in City View Program	41
Co-Sponsored "Why management consulting firms hire PhDs" seminar (with GSC)	130
Co- Sponsored "To Boldly Go: Practical Career Planning for Scientists and Engineers" (with GSC and The Presidents Office which funded this event)	155
Sub-total:	1,080

School of Science Presentations

EAPS Presentation at Orientation	25
Chemistry Presentation at Orientation	25
HST Presentation at Orientation	25
3 Workshops for WHOI-MIT Grad Students	75
2 IAP Panels for School of Science	170
Sub-total:	320

School of Architecture and Planning

IAP internships	12
2 prep sessions for internships (12 students at each)	24
16 architecture and design firm open houses	80
Portfolio Presentation for Employment and Graduate School	20
Intern Development Program (IDP) Information Session	25
Boston Society of Architects (BSA) Information Session	20
Job Search Strategies for Architects	8
Opportunities for Architecture graduates at NBBJ (Seattle) and SOM (Chicago)	28
Sub-total:	217
Department Urban Studies and Planning	
Job Search Strategies for Planners	29
How to Prepare for Career Day	22
Abt Associates employer visit to MIT	16
Sub-total:	67

School of Humanities and Social Science

Introduction to Career Planning for Course 14	8
Making a Good First Impression/Working a Career Fair for Courses 14 and 15	42

Career Planning for students participating in the Washington Internship Program	15
Career Planning for Political Science PhDs	18
Sub-total:	83
Sloan School of Management	
Job and Internship Search Strategies Workshop	6
Professionalism in the Workplace	8
15.279 Spring Interviewing Workshop	25
Orientation to Freshmen	75
Individual Videotaped Mock Interviews for Sophomore Summer Internship Program	2
15.279 Fall Interviewing Workshop	80
Self-Assessment Workshop	2
Sophomore Orientation	73
Making a Good First Impression/Working a Career Fair	21
Sub-total:	292
School of Engineering Presentations	
Fall 1999 Tailored Programs:	
6 Workshops on Introduction to the Office of Career Services and Preprofessional Advising for: LFM, Course 6, Course 1, TPP, Course 10, Course 16 -- undergraduate and graduate students	157
Workshop for Civil Engineering Masters of Engineering Program regarding resume development and career management	45
2 Workshops on Smart Resumes, CVs and Cover Letters for Grad students - TPP	40
Workshop on Smart Resumes, CVs and Cover Letters - Course 16 Internship students	40
Competency Workshop for Course 1 undergraduates and graduates	12
Interviewing Techniques Workshop for Course 1 undergraduates and graduates	15
Evaluating and Negotiating Job Offers Workshop for graduate chemical engineering students	10
Career Services Seminar for freshman chemical engineering students	10
Sub-total:	329
Spring 2000 Tailored Programs:	
Introduction to OCSPA for Material Science and Engineering undergraduates and graduates	40
Introduction to OCSPA for Nuclear Engineering undergraduates and graduates	40
Introduction to OSCPA and Interviewing Skills to SWE (Society of Women Engineers)	21
2 Resume Workshops for VI-A Internship program	8
2 Interviewing Workshops for VI-A Internship Program	12
2 Resume Workshops for Engineering Internship Program	6
2 Interviewing Workshops for Engineering Internship Program	2
CEE Resume Workshop for Civil & Environmental Engineering Internship Program	7
2 Interviewing Workshops for Aeronautics and Astronautics Engineering Internship program	28
Sub-total:	164
GRAND TOTAL:	**2,552**

Table 9. Breakdown of Tailored Programs

	Programs	Attendees
Number Fall 1999	14	164
Number Spring 2000	14	329
1999–2000 Total	28	493

RESEARCH ACTIVITIES

Over 1000 of the June 2000 graduates, 45% of the graduating class, responded to the third annual Survey of Graduates as they picked up their caps and gowns at the Coop during the week prior to graduation. A similar survey was completed by over 1,400 (63%) graduates in 1999 and 1,800 (83%) in 1998.

The survey data analyzed with the assistance of the Office of Academic Services contains information about the demographics of the sample, their post-graduation plans, competency ratings, salary, career resources used, career planning, graduate school information and employment information. Our School-based teams in Career Services

also use this data in helping students learn about the relationship between what they do at MIT and life after graduation.

FRESHMAN/ALUMNI SUMMER INTERNSHIP PROGRAM

Professor Arthur Steinberg turned over responsibility for the Freshman/Alumni Summer Internship Program (F/ASIP), which he created in 1997 at the request of Provost Joel Moses, to OCSPA. Now in its third year, the objective of the program is to give freshmen experience in the workplace with alumni-affiliated companies and mentors during the summer after their freshman year. This formal program achieves one of OCSPA's overall objectives to encourage students to begin their career education early

The internship is augmented by a series of workshops to enhance students' communication, interpersonal and leadership skills. We believe these skills will give students a competitive edge while preparing them for the job market and life beyond MIT. F/ASIP "Alumni/ae" includes: two Class Presidents, a Class Treasurer, a Secretary, and a Member of the Finance Board.

In addition to the internship and workshops, students must also keep journals over the summer, write a paper and give an oral report in the fall. Completion of these requirements will earn the students six credit units in their sophomore year under F/ASIP's subject SP 800. Many students participated in the program realizing that the experience would help to hone their communication and interpersonal skills even if they were not accepted into an internship position.

This year F/ASIP partnered with JobTrak (a web-based recruiting application), to help manage and expedite the internship recruiting process. This process is identical to on-campus recruiting where the students submit their resumes on-line and employers manage the selection process. Our goal is to mimic an authentic college recruiting experience for F/ASIP student participants to enable them to learn job search skills early in their careers.

146 students enrolled in the program, a 184% increase in enrollment. Eighty-one of them landed internships, a 59% increase from last year. We worked with the Alumni Association, Industrial Liaison Program, and the Office of Corporate Relations to identify opportunities and alumni at various companies including: Morgan Stanley Dean Witter, Ford Motor Company, Merrill Lynch, Johnson and Johnson, and Genzyme.

Next year's plans for F/ASIP include enhancement and improvement of the curriculum, expansion of internships to meet students' industry interests and ongoing efforts to ensure that the internships are positive. To date, the demand for internships consistently exceeds the number we have available. We will strive to balance the supply and demand for internships next year.

More information on this program can be found on the World Wide Web at http://web.mit.edu/fasip/www/.

PREPROFESSIONAL ADVISING

In November 1999 OCSPA hired a Coordinator for Preprofessional Advising to work closely with the faculty co-chairs of the new Premedical Advising Council and to oversee implementation of the recommendations of the Premedical Advising Redesign Committee described in last year's President's Report. To date, key initiatives of the Preprofessional Coordinator (in close collaboration with the Council co-chairs) have been: addressing a pressing premedical advisor shortage, revising the premedical advisor assignment process, improving collection and reporting of premedical statistics and finalizing and convening the Premedical Advising Council and the Board of Premedical Advisors.

The charge of the Premedical Advising Council is to "*support the advising relationship between the MIT faculty and other premedical advisors, and MIT students interested in medically-related careers.*" In March, 2000, Council co-chairs Dr. Robert Lees and Professor Chris Kaiser, made a presentation to the Committee on the Undergraduate Program (CUP), about the history leading up to the Council's creation, its goals and the challenges it faces.

In 1999, applicants totaled 165. This is 4% less than in 1998, however still far more than the only 99 that applied in 1988. Of the total, 119 applicants were accepted (a 72% acceptance rate); 87 seniors applied, 72 accepted; 8 graduate students applied, 6 accepted; 70 alumnae applied, 41 accepted. In 1999, 78% of the accepted senior applicants had a GPA of 4.5 or above; 100% of the accepted graduate applicants had a GPA of 4.5 or above; and 57% of accepted alumnae applicants had a GPA of 4.5 or above. In 1999, 99 female applicants applied to medical school and 66 male applicants applied. MCAT scores of MIT applicants averaged 32.1 while the national average for applicants averaged 26.95.

MIT remains an excellent choice for premedical studies, and despite higher criteria for acceptance, our students continue to do well. However, the preprofessional advising system which was designed to handle about sixty students per year has become overburdened and undermined by too few faculty advisors and lack of quality assurance in the face of demand from more than three times the number of students for which it was intended.

EMPLOYMENT RECRUITING

Over 629 employers participated in OCSPA's on-line, web-based employment recruiting program, InterviewTrak delivered in partnership with JobTrak. Through this new system, students, alumni/ae and employers were able to communicate with each other throughout the job search process twenty-four hours a day and seven days a week. Employers posted jobs, students reviewed the job-postings and sent resumes over the Internet and together they were able to build interview schedules.

We currently have 7,794 students and alumni/ae registered with the OCSPA program. The numbers registered by degree include 4,469 undergraduates, 2,042 masters, 86 MBAs, 1,079 doctoral and 18 post-doctoral students. The most sought after students were those with skills, knowledge and experience in information technology, with particular emphasis on new multimedia and Internet technologies. Electrical Engineering and Computer Science was the number one department from which employers sought candidates. Starting salaries for these students also increased this year.

Due to the robust economy and competition among employers to secure MIT graduates, many employers made early job offers during the fall semester. As a result many students found they were either deciding among a number of offers or had accepted an offer earlier than in previous years. Because students were already engaged with employers from the fall, they had little interest in spring interviews, and many employers cancelled spring campus visits. Overall employers made fewer campus visits. A number of employers hired more MIT graduates than in past years.

MIT students in all majors are taking greater advantage of working for start-up companies especially in e-commerce, information technology and telecommunications, given the attraction of pre-IPOs and stock options that are available to them. Students are inundated with job offers that carry salaries that are at an all time high. Many companies are now seeking our advice on how to compete with the phenomenal number of start-up companies.

Employers have learned that students from a wide variety of MIT courses have substantial experience with information technology and are willing to interview students in all majors and at all degree levels. The telecommunications, pharmaceutical, finance and semiconductor industries have contributed noticeably to this demand. Starting salaries have increased, as have the percentage and range of firms offering signing bonuses. Salaries for doctoral graduates in engineering range on the average from $70,000 to $90,000, offers to masters candidates range from $55,000 to $70,000, and to bachelors candidates from $45,000 to $54,000.

OCSPA staff observed increased interest among students in entrepreneurship, biotechnology and pharmaceutical companies, and the business side of technical industries, and decreased interest in working for national defense laboratories.

Employment recruiting is scheduled to almost full capacity for the fall of 2000, which indicates that there will again be a high volume of activity in the fall that will taper in the spring.

PERSONNEL

An important personnel shift occurred this year when the Freshman/Alumni Summer Internship Program moved to OCSPA with the addition of its Program Coordinator. Kori Wyshak was promoted into the F/ASIP position, and Gretchen Black was hired as the Career Development Counselor for the School of Science replacing Kori.

Also during the year two searches have been conducted and continue, for an Assistant Director for Employer Relations and a Career Development Counselor for the School of Engineering. This latter search resulted from the conversion of a support staff position to provide more direct service to the students of the largest academic unit. In addition, three new individuals filled existing support staff positions. An Asian female and an African American female were also hired as Career Assistants.

All new professional staff have master's degrees in counseling and experience in career development.

FUTURE PLANS

OCSPA continues to seek to integrate a career development focus for learning, through the Comprehensive Student Plan for Career Development that has been constituted with input from faculty, students, employers, alumni and other administrators. An essential part of the plan is the concept of integrating career management education into students' academic experience. We are introducing students to the concept of competency development and the importance this has in future outcomes of their career choices.

OCSPA strives to integrate its work with developmental theory presented in research and literature, and with the educational mission of ODSUE; to that end, OCSPA will continue to teach students to become self-managed learners, to develop their competencies; participate in hands-on learning in the real world; and develop an understanding of careers as life, not a job. We will do this by increased staff and student/faculty interaction; our expanded web site; participation with the faculty in programs that they offer and continued outreach to faculty to engage in more career-related programs; and seek to integrate career/life learning with the curriculum.

Continuous data collection is required to serve as a basis for decision making and to provide a basis for analysis and outcomes assessment in order to measure the quality of our services, and from which to provide statistical reports, including feedback to the Institute on where students go and what great things they do. Continued support of OCSPA's efforts is required to actualize the department's potential.

OCSPA continues to evolve as a student-friendly and learner-centered service to our students and the MIT community. As visitors to OCSPA note, they only recently realized what a valuable resource was available.

More information about this department can be found on the OCSPA web site at http://web.mit.edu/career/www/.

Christopher Pratt

OFFICE OF MINORITY EDUCATION

The primary purpose of the Institute is to provide a rigorous venue for education and related research, which is relevant to the practical world. As a result of this reaffirmation, the Office of Minority Education (OME) has strengthened its long-standing partnership with MIT's educational goal for its students who come to the Institute to aspire to be engineers and scientists.

To that end, the Office of Minority Education strives to provide effective academic enrichment programs to enhance matriculation, promote higher retention and greater excellence in underrepresented minority (African American, Mexican American, Native American and Puerto Rican/Hispanic) student academic and general educational achievements, and to encourage their pursuits of graduate degrees and professional careers. OME's mission embraces a strategy to address academic and graduation gaps between underrepresented minority and non-minority students on MIT campus.

Goals are:

- To offer an introduction and orientation to MIT which will facilitate the adjustment of minority students to the academic environment at MIT.
- To strengthen ties and relationships with academic and other support offices to increase the visibility and use of OME resources.
- To re-establish an effective freshmen advising program for underrepresented minority students that will focus on academic and social transitions to the rigors of MIT.
- To design and implement an infrastructure to support academic advising in the Schools of Engineering, Science and Humanities and Social Sciences to encourage and actualize higher academic performance within underrepresented minority students.
- To determine what variables or conditions influence underrepresented minority student achievement and retention.
- To develop and implement a Minority Student Leadership Institute with focus on leadership development for underrepresented minority students in engineering.

This year, the Office of Minority Education continued to support and provide underrepresented and majority students with a selection of academic enrichment programs designed to enhance their opportunity to be successful at MIT and beyond. Members of the staff of the Office of Minority Education delivered effective programs to a broad

range of minority and non-minority communities within and without the Institute. In addition, the OME provided programs and opportunities to both its private and public constituencies during the course of the academic year.

Due to an effective recruitment strategy by the Admissions Office, MIT experienced a growth in underrepresented minority students over the last ten years. The staff of the OME has remained constant over the same period. This year the minority student population totals 792 or 18% of the 4,500 (approximately) undergraduate students attending MIT. Faculty, staff and students continue to enhance their visibility and accessibility as they increase the quality of services offered to the underrepresented student population.

With the assistance of members of the MIT community, representatives of the Industrial Advisory Council for Minority Education, alumni/ae of color and faculty, the OME was able to present a compelling argument to increase staff in the Office. During the fiscal year 2001 budget process, the Office of Minority Education was awarded an additional personnel slot to address an unmet need within the minority community.

The OME has strengthen and established new partnerships with departments in the Office of the Dean for Students and Undergraduate Education and other departments throughout MIT. During the summer, the OME developed a partnership with the MIT Space Grant Consortium to provide scholarship support to two underrepresented minority students who are majoring in engineering. The candidates were selected from a pool of applicants who applied for the scholarship through the Office of Minority Education. After an initial screening process, the finalist applications were reviewed and approved by the Director of the Space Grant Consortium. Both areas anticipate that two additional minority students will be selected for awards for the 2000–2001 academic year.

In 1998–99, the Institute became aware of the lack of minority student participation in the Undergraduate Research Opportunity Program (UROP). In response, the OME implemented a new initiative with 3M Corporation to provide funding and support to increase the number of minority students participating in UROP. During the spring term, we were able to support sixteen underrepresented minority students, thereby increasing the participation rate of URM students.

In addition, the OME has forged a partnership with the National Aeronautical and Space Administration (NASA) Undergraduate Research Scholars Program through participation in a consortium of eight selected universities (MIT, Purdue University, Stanford University, Texas A&M University, University of Alabama, University of Central Florida, University of Maryland and University of Michigan). The purpose of the NASA Scholars Engineering and Science Collaborative Program is designed to address the severe shortage of minority undergraduate researcher in the fields of engineering and science. Students who are selected as scholars receive both scholarship support and funding for research in the field of engineering and science.

To achieve the goals of the NASA Undergraduate Research Scholars Program, the Principal Investigator for NASA has selected four sites to be Summer Institute Research in Science and Engineering (RISE). The Summer Institute RISE offers a four week program focused on providing students with a seamless progression of academic, research and work experiences that will develop strong applicants for more intensive summer and permanent research positions. Four MIT students and three students from City College of New York were selected to participate in the program this year.

As ex-officio members of several Institute Committees, the staff of the OME persistently focused its ability to work in an advocacy role on behalf of underrepresented minority students.

During last year, the OME pursued major discussions on retention and academic performance of underrepresented minority students. As a result of the review the overall academic performance of minority students, the OME has recommended that academic programs be established for students of color in their sophomore year to assist minority students in their transition into the various departments. The OME XL Program which focuses on collaborative learning and peer support might be expanded to achieve this goal.

OME PROGRAMS

Project Interphase

Project Interphase is one of MIT's major commitments to ensure the academic success of its underrepresented minority students. This academic enhancement program enrolled one-third of the admitted underrepresented minority students, who decided to attend MIT. Students must submit an application to be selected for the program. The program offers an eight-week rigorous academic experience during the summer prior to the first year. The

curriculum includes Physics, Calculus, Chemistry, Writing, Physical Education and a myriad of co-curricular activities. In addition, students participate in a design project, which provides opportunities to develop team-building skills. This is one of the first phases of the program and is geared to shaping student commitment to the Project Interphase community.

An academic staff of tenured faculty and instructors, with the assistance of graduate and undergraduate tutors, make up the teaching core of Project Interphase. Faculty and tutors make a major contribution in preparing underrepresented minority students for the rigors of MIT. Through teaching, advising and mentoring, they promote and support the intellectual development of the program participants.

Ethnic and gender profile

Sixty-two students were accepted for Project Interphase 2000, and 59 students participated in the program. The ethnic and gender profiles are consistent with previous years and closely reflect the ethnic and gender breakdown of the class of 2003. Twenty-seven (27) African Americans (students of African descent) participated in the group accounting for 46% of the total. In addition, there were 22 Mexican Americans (37%). Puerto Ricans represented 25% of the 59 participants. This represents a slight increase in overall participation of Latino students in the program. There was also a slight increase in the participation of Native American in PI '99 with 3 students or .05%. This year's program also saw a marginal increase in the number of women participants with 18 (33%).

Academic Measurable

Project Interphase continues to develop ways to prepare students for the fall term and beyond. Fifty-nine students who participated in Project Interphase '99 received full credit for Project Interphase. A high percentage of the students who took the advanced placement test for 18.01 received Advanced Placement credits. Thus, they were able to take a higher-level mathematics class during the first semester. Several students also passed Phase I of the writing requirement. These positive outcomes reinforce the value and success of Project Interphase.

Program XL (Excel)

XL continues to be an effective academic enrichment program for first-year underrepresented minority and non-minority students. Participants who enrolled in the program were divided into small collaborate/interactive learning groups focused on Calculus, Physics, Chemistry and other freshmen core courses. These learning groups conducted one and half-hour sessions twice a week during the fall and spring terms. XL facilitators, who are upper class and graduate students and represent a broad range of ethnic backgrounds, coordinate the learning groups and oversee the interactive discussion of materials.

Participation of the Class of 2003 during the 1999–2000 academic year was consistent with previous years. One hundred and nine (109) students participated in over twenty-seven learning groups. The following are Program XL statistics for 1999–2000:

Table 10. XL Program Participants Ethnicity

	Enrolled	Completed	Ethnicity
Fall '99	68	55 (80%)	African American, Asian American, Hispanic, Native American, Caucasian, and others (African and Caribbean)
Spring '00	41	28 (70%)	African American, Asian American, Hispanic, Native American, Mexican American, Caucasian, and others (African and Cape Verean)

Tutorial Service Room

The Office of Minority Education's Tutorial Services continues to provide effective academic support to a significant number of underrepresented minority and non-minority students. This year, the TSR experienced a growth in the number of student users (see TSR Report) as the result of an improved marketing strategy on the part of the student managers. The OME employed over one hundred tutors from broad array of ethnic backgrounds and disciplines to tutor in over fifty courses. The Director of the OME, in conjunction with the Assistant Dean/Assistant Director, interviewed, hired and trained all tutors for the program. To ensure quality control within the program, all tutors' academic records were verified to make sure that all tutors were at the B requirement level.

Table 11. TSR Annual Report: Academic Year 1999–2000

Total Number of Student-Clients: 787 (Fall + Spring Totals. Includes some repeat users)
Total Number of Visits: 1,600
Total Number of Service Hours: 2,229.8 (Includes tutorials, independent learning and Athena usage)

Table 12. Service Hours by Class

Class	Hours	Percentage
1	1,480.8	66.4
2	314.3	14.1
3	64.5	2.9
4	27.8	1.3
5>	25.0	1.1
Unspecified	317.5	14.2
TOTAL	**2,229.8**	**100.0**

Table 13. Service Hours by Type of Service and by User Ethnicity and Gender

	Tutorial Hours		Independent Study Hours*		Athena Use Hours*	
		Percentage		Percentage		Percentage
Ethnicity						
Asian	349.0	16.3	0.0	0.0	0.0	0.0
Black	329.5	15.4	26.3	30.8	3.0	40.0
Hispanic/Latino	421.3	19.7	31.8	37.2	0.0	0.0
Native American	22.8	1.1	0.0	0.0	0.0	0.0
White	112.8	5.3	5.8	6.7	0.0	0.0
Other	235.3	11.0	2.0	2.3	0.0	0.0
Unspecified	666.5	31.2	19.5	22.9	4.5	60.0
TOTAL	2,137.0	100.0	85.3	100.0	7.5	100.0
Gender						
Male	712.8	33.4	30.5	35.8	3.0	40.0
Female	1,131.3	52.9	40.3	47.2	1.5	20.0
Unspecified	293.0	13.7	14.5	17.0	3.0	40.0
TOTAL	**2,137.0**	**100.0**	**85.3**	**100.0**	**7.5**	**100.0**

* "Athena Use" is sometimes hidden as "Independent Study," and vice versa.

Second Summer Program

For the past twenty-six years, the Second Summer Program (SSP) experience has provided opportunities for students between their freshman and sophomore years to explore engineering and science experiences beyond the classroom. SSP is an academic program that enriches and supports intellectual growth while assisting them to develop a keen sense of professional possibilities. Program interns explore possible fields of interest, while making real contributions to the work of their assigned companies. When they return to their classrooms in the fall of their sophomore year, they have a depth of knowledge and experience that greatly enhances learning in engineering and science.

This year, 32 students qualified to participate in the Second Summer Program by attending three orientation sessions and passing the freshmen core curriculum of calculus, physics, and chemistry or biology during the first semester. In addition, students interested in the program were also required to participate in the Program's Engineering Design Workshop during the Independent Activity Period (IAP). In this workshop, Professor Alexander Slocum, a MacVicar Fellow in Mechanical Engineering, divided participants into teams that were required to design and build a device or product for the home. At the end of the two-week period, all teams presented their final product at the program's engineering design competition. Professor Slocum has circulated the winning entry to various companies to see if there is any interest in further development. After completing the SSP Engineering Design Workshop, participants engaged in an intensive interview process with companies that belong to OME's Industrial Advisory Council for Minority Education (IACME). Thirty students were placed at 13 companies in engineering intern positions. The faculty continues to strengthen its partnership with the OME/SSP by volunteering to visit interns on-

sight. Faculty and administrators will visit all 30 interns during the summer months and will submit reports on student experiences and progress.

In the spirit of continuous educational improvement, the Office of Minority Education with the financial support from 3M Corporation added a research component to the program. This allows students to participate in UROP to further develop their product under the supervision of Professor Slocum. Thus, the Second Summer Program has evolved to include three components: work readiness, engineering design workshop and research. This effort has increased number of minority students participating in UROP.

Over the last five years 235 minority students have participated in the Second Summer Program. None of these students has received any academic action. Furthermore, with Professor Slocum's support and guidance, four product patents have been awarded to several teams. In addition, there are currently two patent applications in the pipeline with an additional patent application to be submitted in late August 2000. These achievements testify to Professor Slocum's commitment to helping students realize their maximum potential.

Industrial Advisory Council for Minority Education
The Industrial Advisory Council for Minority Education (IACME) is intended to promote greater retention and higher academic achievement of MIT's underrepresented minority students through active support of, and participation in, the realization of the OME's mission and goals.

To that end, members of IACME provide financial support to enhance the OME's ability to organize effective academic and professional development programs to assist professional student organizations: AISES (American Indian Science and Engineering Society), NSBE (National Society of Black Engineers) and SHPE (Society of Hispanic Professional Engineers). Over the course of the academic year of 1999–2000, the OME contributed over $10,000 to support a broad range of professional and cultural organizations.

In addition, members of IACME continue to take a leadership role in discussing a variety of issues that impact the academic success of underrepresented minority students at MIT. Several members of IACME are concerned about the relatively low participation of minority students in UROP. 3M Corporation has taken a leadership role in establishing a fund to increase the number of minority students supported on UROP projects.

Secrets and Strategies for Academic Success (SSAS)
Since the inception of OME, SSAS has been one the core programs offered to underrepresented minority students. The primary aim of the SSAS program is to expose underrepresented minority students to the Institute's survival network of academic and support services. This year, coordinators of the SSAS Program observed a significant increase in participation by underrepresented minority students in the sessions held both during the Fall and Spring terms. The following topics were offered during:

- "Time Management"
- "Ways to Develop Effective Learning Skills"
- "How to Choose a Major"
- "Planning for Graduate School"
- "How to Succeed at MIT"

OME ADVISORY COUNCIL

The Office of Minority Education Student Advisory Council was created to provide a forum in which minority students could voice their concerns and bring issues to the attention of the Associate Dean of Undergraduate Education and Director of the OME. OMESAC's membership consists of a cross-section of underrepresented minority student professional and social organizations.

During the 1999–2000 academic year, OMESAC increased its presence in both the minority and non-minority communities. This year, OMESAC forged a stronger relationship with the Admissions Office in support of MIT's annual Campus Preview Weekend (CPW). OMESAC hosted activities, programs and housing for minority students who attended the CPW. Next year, OMESAC plans to host a Leadership Retreat for its membership.

MINORITY SCHOLARSHIPS

The OME continues to be a repository for information for internships and scholarships that target underrepresented minority students. Minority students receive scholarships from public, private and corporate organizations. This

year, the OME facilitated partial and full scholarship support for over thirty minority students, with amounts ranging from $1,000 to $26,000 to be applied to tuition, room and board, fees and books.

MINORITY AWARDS BANQUET

The Office of Minority Education hosted the Twenty-Fourth Annual Minority Awards Banquet at the end of 1999-2000 academic year. The Office of Minority Education, the Counseling and Support Services, the Graduate Students Office and the Office of the President supported the Awards Banquet. Over one hundred and fifty faculty, administrators, staff and students attended the event to recognize the achievements and accomplishments of our minority students. Graduate and undergraduate students received academic and community service awards for their contributions to improve the quality of life for minority students at MIT. This year, two hundred and fifty academic awards were presented to underrepresented minority students who had achieved a 4.0 GPA. This year, Professor Evelynn Hammonds, Associate Professor of History of Science and Secretary of the Faculty, presented the academic awards to students in the sophomore, junior and senior years.

More information on this department can be found on the World Wide Web at http://web.mit.edu/ome/www/.

Leo Osgood, Jr.

OFFICE OF STUDENT CONFLICT RESOLUTION AND DISCIPLINE

The Office of Student Conflict Resolution and Discipline (OSCRD) received formal complaints of personal misconduct against thirteen students and two student living groups during the 1999-2000 academic year. Eleven of the charges were handled by administrative review, while four were heard before a five member Dean's Office hearing panel. A hearing panel will hear two additional charges during the summer. The OSCRD also began work on three other cases. For these three, one resulted in the charges being dropped, one was resolved with a warning letter and one was settled in mediation.

The administrative reviews, which are conducted by an administrator and a student, resulted in a wide array of sanctions ranging from warning letters, to Institute service, to loss of housing privileges. Of the four charges heard before hearing panels, two resulted in letters of reprimand, while two saw recognition of a student group, as well as the housing for that group, revoked by the Institute.

The OSCRD also received warning letters against fourteen students. Of these, ten were for academic misconduct and four were for personal misconduct.

As in the past, the Office of the Dean of Students and Undergraduate Education (ODSUE) in conjunction with the Committee on Discipline will continue to report disciplinary actions at Faculty meetings. We hope that this will alert the community to the need for consistent reporting of incidents to ODSUE or to the Committee on Discipline so that students may become more aware of the risks they run when engaging in academic or personal misconduct.

Betty Sultan

RESIDENTIAL LIFE AND STUDENT LIFE PROGRAMS

In its second year as an organization, Residential Life and Student Life Programs continued the process of organizational change and development. The theme of RLSLP's completely revised web-site, "Thrive: Living at MIT," modeled a goal of the entire organization based on the Task Force Report on Student Life and Learning: to create an environment at MIT in which students, faculty, and staff can thrive. In this regard, emphasis was placed this past year on organizational development, processes, skills, and competencies. An organizational model that better met the needs of RLSLP was developed and implemented. Key staff positions were evaluated, revised, and filled with people both from within and outside of RLSLP. Work was done with the Stillwater Group to examine a number of our business processes and to develop a full-cost financial model that will allow us to examine financial scenarios and factors for maximum utilization of our housing assets. As a result of this work and more, RLSLP has a much stronger foundation to build on to do the exciting work at hand.

This exciting work first continues the implementation of the Task Force Report on Student Life and Learning. Emphasis on developing excellent programs and facilities to strengthen the community and better integrate student life and learning was one of this past year's goals. Another was the re-design of MIT's residential system to better provide a living environment that truly integrates and fosters student life and learning. Following on the work of the Residential System Steering Committee and the Strategic Advisory Committee to the Chancellor, the Chancellor in

December issued "The Design of the New Residence System" and appointed Dean Kirk Kolenbrander Special Assistant to the Chancellor for the Residence System. This design will provide a blueprint for RLSLP and others to guide our work, mission, and goals, with our mission defined as follows.

The mission of the office of Residential Life and Student Life Programs is to support the education of the whole student, including intellectual, personal and social growth. We facilitate both graduate and undergraduate student learning beyond the classroom in residences and student organizations. Through our office, a variety of opportunities are created which promote faculty and student interaction, encourage student responsibility and support a high standard of conduct in accordance with MIT policies and procedures. We strive to provide a safe environment for our students, by developing and maintaining facilities of the highest quality in support of the Institute's broader educational mission. By providing programming support for student events and activities, community service initiatives, and student organizations, we foster the development of essential life skills that will allow students to establish meaningful relationships within the MIT community and beyond. We maintain the flexibility for students to pursue different housing options both on and off-campus. Both residential and non-residential opportunities enrich students' educational experience by providing exposure to different cultures, ideas and perspectives.

STUDENT ACTIVITIES AND STUDENT ACTIVITIES FINANCES

Event support and advising continued to grow: Domecoming and Spring Weekend continued to be popular, well-attended programs. Mark Tracy, graduate intern for Multicultural programs, worked with a variety of programs, including the advising of student of color organizations and a program on interracial dating. Strong relationships with student publications through the Publications Board continued, and work has been started with *The Tech* to improve their business operations.

Student Activities Finances now supports over 275 internal bank accounts for MIT student groups using the SAP system, and monitors outside bank accounts in collaboration with the Treasurer's Office. All information is now available for students to access on-line, and all office services are listed on the web page.

CAMPUS SOCIAL LIFE/FUNDING

An increase in funding for the UA Finboard and through the MIT Fund allowed more community-wide and co-sponsored events to occur on campus. The Request for Funding process has been streamlined, with an increased effort to communicate availability and process to departments and student groups. A close working relationship was established between the Student Activities Finances office and the UA Finboard.

WEEKENDS@MIT

Weekends@MIT, a collaborative effort by RLSLP and the Dormitory and InterFraternity Councils, is a new funding mechanism for student initiatives that was created to support and encourage living group efforts to plan campus-wide events. This year, Weekends@MIT distributed $13,500 during the spring term to fund six events, with a combined attendance of over 2,000 MIT or admitted students, which were sponsored or organized by nine different living groups in addition to DormCon and/or IFC. A donation by Thomas Glenn Leo '75 has provided additional funding to support the goals of Weekends@MIT over the next five years. DormCon, IFC, RLSLP, CAC, Athletics, and several other student groups also collaborated in reviving Homecoming at MIT. The BBQ, Homecoming Ball, and Alley Rally were all well attended. The Homecoming football game had the highest attendance of any football game in the last few seasons.

LESBIAN, BISEXUAL, GAY, AND TRANSGENDERED AT MIT (lbgt@MIT)

Additional funding enabled increased support of student groups and improved programming and services through the hiring of a graduate assistant. A logo was designed for use by all LBGT groups to unify the varied efforts on campus. The "You are Welcome Here" Campaign was launched, through which over 500 signs were hung by faculty and staff to demonstrate their commitment to supporting MIT's LBGT community. A monthly e-mail newsletter, which includes upcoming events and educational topics, was begun with an initial circulation of over 500. New material in this year's Lavender Guide focused on improving coverage of lesbian and transgendered resources. Distribution of the Guide doubled to nearly 1,500. An online version is also available.

New this year were an event during Campus Preview Weekend and "Living Pink," a guide to LBGT friendly living groups to assist incoming freshmen in making their choice of residences. Events for Coming Out Week in October and ToBGLAD in March continued to be well attended. MIT also became a member of the National Consortium of Directors of LGBT Resources. This year's efforts were made possible through the financial support of John Kellett

'47 with additional assistance from the Health Education Service of MIT Medical, Dean for Student Life, Orientation 1999, Counseling and Support Services, and the Publishing Services Bureau.

LEADERSHIP TRAINING AND ORGANIZATIONAL DEVELOPMENT

Event planning workshops were held in conjunction with the Campus Activities Complex and were attended by over 30 student organizations. The UA, GSC, and Student Activities Finances collaborated on a Treasurer's Training, a multi-media presentation that allowed groups to learn and view their account activity while learning the processes. Training for individual groups was given on a request basis. The Resource Library for teambuilding exercises and general information continued to grow.

PUBLIC SERVICE CENTER

The Public Service Center (PSC) contributes to the education of students by providing opportunities to experience service and by nurturing committed and sustained involvement within the community. Many of our programs focus on efforts that enhance public education in Cambridge, while adding an extra dimension to the learning experience of the MIT students who participate each year. The PSC also serves as an umbrella for various campus groups that engage in community service as well as for groups and individuals who wish to become more involved. Over one third of the MIT undergraduates participated in at least one of the PSC sponsored programs this past year.

In this year's CityDays program, 550 MIT students participated in a brief training period, and then worked directly with children, teachers and administrators in 13 elementary schools in Cambridge. MIT students were able to bring their experience and enthusiasm for science, engineering and technology directly into the Cambridge classrooms.

The LINKS program, with the mission of improving the quality of science education in the Cambridge Public Schools, had about 40 volunteers during the fall semester and 60 in the spring. Reach Out–Teach a Child to Read (just finishing its third year) provided student reading mentors at Cambridge Community Center, Cambridge YMCA, and Boston's Hurley Elementary School, with approximately 100 mentors participating over the two semesters. KEYs to Empowering Youth ran five one-day programs and a three-day summer program, which allowed approximately 160 girls and over 30 MIT students to participate in one or more programs.

The eighth annual MIT/Cambridge Science Expo brought 250 seventh and eighth graders from Cambridge schools to campus to exhibit their science projects, participate in hands-on experiments, and tour Institute labs. Approximately 150 MIT student volunteers helped make this event possible both before and during the event.

This year's IAP program was expanded to include 11 more students than last year. Twenty-six fellowships of $1,200 each were awarded over IAP this year to students who journeyed into the Cambridge Public Schools daily for a total of 100 hours each during the month of January.

This summer, five fellowships have been awarded to students who will work a minimum of 400 hours in various community agencies around Cambridge and the Greater Boston area. Five of the fellows were awarded $4,000 each for 400 hours of service. The fellows are assigned to Peabody Properties (Charlestown), Patriot's Trail Girl Scout Council (Boston), MY TOWN (Boston), SummerBridge (Cambridge), and the Jamaica Plain Arts Council (Boston). One $2,000 part-time fellowship, sponsored by the MIT Women's League, was awarded for work at On the Rise in Cambridge.

The Alternative Spring Break program had over 80 volunteers who devoted their spring break to community service. This year's trips/programs included Teach for America, Habitat for Humanity, a teaching trip to Puerto Rico, an AIDS awareness trip to New York City, a comparative health policy trip to Montreal, an environmental awareness trip to Albany, New York and a conservation clean-up trip to Camp Spears in Pennsylvania.

The Lord Foundation has continued to grant funding of $50,000 for the Fellowship Program and other collaborative programs with the Cambridge Public Schools. The PSC was also a successful grant recipient of the Massachusetts Campus Compact VISTA Program and will have an AmeriCorps*VISTA member serve full-time for one year at the PSC. Approximately $85,000 has been donated to the Priscilla King Gray PSC Endowment Fund over the past year. These funding sources have made it possible for the PSC to support programs and campus community service efforts, including "Service in the Community Oriented towards Race Relations Enhancement" (S.C.O.R.E.) sponsored by Order of Omega, and the Rhythm of the Youth Workshop, sponsored by Groove Phi Groove. The PSC is actively seeking additional funding through foundations and individual donors to support PSC activities.

RESIDENTIAL PROGRAMS

Significant progress was made in building a collaborative relationship with a variety of offices, particularly the Office of Academic Services (OAS). The Tuesday Night at Baker Series was organized to provide a weekly programming and educational workshop to enrich students' ability to navigate through the resources and services of MIT. The Health Education Service of MIT Medical joined OAS and RLSLP in the creation of a pilot program in residence based advising which received a d'Arbeloff Grant and will be conducted during the coming year. Efforts were also made to work with other offices and academic departments that may be interested in sponsoring events and programs within MIT's living groups. In addition to weekly meetings with its leadership, we worked with Dormitory Council to organize their annual officer transition process, including a weekend goal setting and team building retreat.

HOUSE FELLOWS AND RESIDENTIAL SEMINARS

Nineteen faculty and one alumnus served as House Fellows in undergraduate and graduate residence halls. House Fellow programs covered a broad range of activities including a Chinese New Years' Dinner, retreats at Talbot House, Intramural Bowling, and working with Senior House residents to build a courtyard hammock.

Working collaboratively with the Experimental Studies Group, RLSLP offered two seminars in MIT residence halls. Random Hall hosted SP.742 "Robotics and Mechatronics Projects" taught by Ben Davis in which 14 students enrolled. Bexley Hall explored the chemistry behind everyday cooking through Patricia Christie's "Kitchen Chemistry" in which 16 students enrolled. Feedback regarding both of these seminars was very positive.

FACULTY AND GRADUATE RESIDENTS

Training for the 145 people who make up the Residence Teams (Housemasters, Graduate Resident Tutors, Graduate Coordinators, House Managers, and Resident Assistants in FSILGs) took place in August, January, and June. Sessions focused on fire safety, resources at night, religious diversity, and dating violence. Eighteen new GRTs were selected to replace people leaving. The Housemaster couple at Bexley left, and Senior Associate Dean Robert Randolph and his wife Jan Randolph have assumed that position on an interim basis, for up to three years. Recruiting tenured faculty members for Housemaster positions continues to be very difficult.

UNDERGRADUATE HOUSING

This year a second lottery was necessary for incoming first year students. We placed approximately 98.7% of students in one of their top three choices, down from 99.7% in 1998. We are currently testing a java-based genetic algorithm for the Fall 2000 lottery to optimize the assignments process. In cooperation with the Dormitory Council, we will experiment with using the lottery system for temporary assignments to model the proposed 2002 housing process and study the effects temporary housing assignments have on permanent housing choices and assignments.

Crowding of first-year students has been an increasingly difficult problem. While projecting 40 fewer crowds this fall (due to a smaller entering class size) we still anticipate levels of crowding that could force us to utilize Macgregor lounges. The ultimate level of crowds will depend on the number of students who pledge FSILGs. Due to the high crowding estimates, students who are not guaranteed campus housing under MIT Policies (including transfer students, among others) have little or no chance to move back to on-campus housing in the Fall of 2000.

Housing information has been incorporated into the RLSLP web site and the Orientation web site, so that incoming students and their families will be able to investigate the residences on-line before arriving on campus.

SINGLE GRADUATE AND STUDENT FAMILY HOUSING

Housing availability in the Boston area rental market continues to decline while prices escalate rapidly. In addition, the number of rental postings is declining, another indication of a poor rental market for newcomers. MIT accommodates 30% of all graduate students on campus. We accommodate 90% of single students but are far below this level with student families. Our on-campus rents are below market—a very attractive alternative for our graduate population.

Many local rents now exceed the average graduate student's monthly stipend. The Off-Campus Housing Service is referring more students to Student Financial Services in an attempt to increase their support so that they can afford to live in the Boston Metropolitan area.

We continue to have success with the Plan to House New Graduate Students— a policy developed many years ago to provide more on-campus housing to entering graduate students. A new on-campus graduate facility (NW30) is in

the design phase and should open for academic year 2002 (September 2001). We continue to encourage development of more graduate student housing resources.

OFF-CAMPUS HOUSING SERVICE

The Off-Campus Housing Service is developing an on-line, web-based rental listing program that will help students, staff and faculty locate local housing. We have approval for a full time support staff position to assist in the maintenance of this intricate database. Our goal is to have the database on line for testing purposes during the Fall Term 2001 (October 2000).

SUMMER HOUSING

Currently we attempt to meet the needs of four groups who use the ten undergraduate resident halls during the summer. These include: students: MIT undergraduates and graduated seniors and Wellesley students; Conference Services; Special Department Programs, including pre-freshman and minority programs; and Department of Facilities and RLSLP construction and renovation staff.

With all need to accommodate all four groups in each of our halls, there is often dissatisfaction. Students are concerned about how summer housing is assigned while Conference Services and departmental administrators have concerns about the availability and quality of accommodations. Facilities managers are required to work with tight timetables to complete construction and renovation projects. In addition, the programs, house governments, and other student support systems that are "normal" in the academic year are absent during the summer months. We have hired a Summer Intern to help us analyze these situations and develop a new plan for summer residence hall utilization.

FRATERNITIES, SORORITIES AND INDEPENDENT LIVING GROUPS

This year, 386 entering students pledged or accepted residence in one of MIT's 36 affiliated ILGs. This number significantly exceeded RLSLP expectations when compared with last year's total of 316 and was above the ten-year norm of 365-375.

In August, Sigma Nu fraternity moved into 28 The Fenway, the former residence of Phi Gamma Delta Fraternity. Sigma Nu has negotiated with the Malcolm Cotton Brown Corporation (Phi Gamma Delta's house corporation) to lease the property for the next few years.

All 36 ILGs opened the year with a resident advisor in place. The resident advisors have become valuable resources to both their living groups and RLSLP. In the past year, several RAs were extremely helpful in emergency situations and have provided a valuable link to the living group for various Institute offices including Counseling and Support Services, Academic Services, MIT Medical and Campus Police. Their presence has also smoothed relations with the Boston Licensing Board and the Cambridge License Commission.

In October, Sigma Alpha Epsilon Fraternity had their dormitory license revoked by the Boston Licensing Board as a result of alcohol violations that occurred at a house earlier in the semester. On November 10, a Dean's Hearing Panel revoked Institute recognition of the fraternity. This decision was supported by a vote of the Interfraternity Council. The freshmen residents of the fraternity were moved into spaces in the MIT residential system while upper-class members of the fraternity obtained housing elsewhere in the community.

MEDIATION@MIT

Demand for training in various types of conflict resolution continues to grow. Mediation@mit offered the 36-hour Basic Training in Mediation twice this year and graduated thirty-two new mediators. Mediation@mit staff provided conflict resolution training for GRTs in August and, with the Ombudspeople, taught the 27-hour Conflict Resolution class for twenty Dean's Office staff members. A new program developed with a graduate intern over the summer created two new 1.5-hour workshops on "Fair Fighting" and "Size Matters Not: Negotiating in a Power Imbalance," which were offered in five different residence halls. Five formal mediations took place; one matter was resolved during pre-mediation discussions; and mediators facilitated one group discussion in a residence.

DISCIPLINE

Improving the organization and systemization streamlined the process of reviewing non-academic discipline matters, resolving relatively minor cases and referring more serious ones for formal procedures. Of 173 cases warranting opening a record, there were 40 alcohol infractions, 32 accessing roof or restricted area (some group incidents), 15 harassment cases, 12 property damage, 10 assaults, and 64 other types of cases. Cases against 23 students were

referred for administrative review or hearing. Three of these cases were concluded by mediation. Hundreds of Campus Police reports were reviewed to winnow the cases requiring further action.

Coordination with Campus Police, Housemasters, RLSLP staff, Stopit, the Program Administrator for Student Conflict Resolution and Discipline, Deans on Call, and others is helping to identify matters requiring investigation while preventing duplication of effort or inconsistent management. A database now exists of the 346 students involved in some way with the discipline system since July 1998.

DEAN ON CALL

The four-person Dean on Call team provided night and weekend presence of the Dean's Office on campus during the events and immediate aftermath of three self-inflicted deaths and one almost fatal fall on campus this year. In addition the team handled twenty-six other serious matters and fielded dozens of calls at night and on weekends from students, Housemasters, parents, and Campus Police.

RESIDENTIAL FACILITIES OPERATIONS

Our goals include increasing undergraduate and graduate residential facilities; constructing a new 2002 undergraduate dorm; renovating NW30 for graduate housing; planning for construction at the Sydney/Pacific site for a graduate residential complex; in conjunction with Dining Services, exploring possible renovation of existing closed residential hall kitchens and renovate housing suite kitchens to become bed space, creating both an enhanced community dining program as well as increased bed space and income generation; and exploring the current graduate housing usage of Ashdown House, i.e. large vacancy loss as well as under-utilized large function space.

Deferred maintenance levels 1 and 2 as well as renovations that benefit residential programming by utilizing the Department of Facilities, Facilities Audit as a road map, and continue to deploy reserve dollars to address life safety and building envelop deferred maintenance issues and provide space enhancements and renovations to meet the needs for residential programming.

Re-structure the Offices of Undergraduate Housing Assignments, Graduate Housing and Off-Campus Housing by bringing these three separate offices together to serve graduate and undergraduate students, staff and affiliates that are seeking on- and off-campus housing more efficiently. Include summer residents and guest housing for a full 12 month housing program. Cross train and develop all staff to operate in this new system. (Note: Departmental re-structuring will require space re-allocation to support the physical consolidation of the various offices).

The Institute has committed approximately $32 million to begin a Life Safety/Fire Safety System Renewal program for the residential facilities. This summer East Campus and Random Hall are closed for extensive construction renewal work. RLSLP members of the project team continue to plan the next phases of the program.

The RLSLP Fire Safety Committee worked closely with residents to produce programs that enhance overall safety in residential facilities. Evacuation plans and signage have been upgraded. Spring fire drills went extremely well and helped us to identify and correct system problems. A safety inspection program will be implemented in the fall.

Construction and renovation proposals were reviewed to ensure that they meet two objectives: to reduce deferred maintenance, and add to the life of the building for student programs. To ensure that houses received detailed information regarding summer work, meetings were held in each house with the Housemaster, House Manager, Manager of Construction and Renovations and a House Officer.

Funds were secured to renovate the Housemasters' kitchens at Next House and McCormick Hall. These renovations will provide additional space and upgraded equipment giving the Housemasters more opportunities for events with their residents involving food. We are also renovating the McCormick Dance Studio and will be providing a much needed floor kitchen to the McCormick Annex. The planning and bid phase has begun for the Westgate playground renovation, a project that will greatly benefit the families and children of Westgate. Routine renovations of bathrooms, kitchens, painting and carpet replacement are ongoing in residence halls this summer and fall.

Completed Capital Maintenance Projects for Fiscal Year 2000
Window Replacement/Window security screens: NW61, W85
Waterproofing/Pointing: E55, W84, W85, W13, W51
Bathroom Renovations: E55, 62-64,W13, NW61, W4, W51, W61, W70, W71, W85, W5, W1
Kitchen Renovations: E55, 62-64,W1, W4, W5, W51, W61, W85, W70, W13, W71
Plumbing/Mechanical Renovations: E55, 62-64, W1, W13, W4, W51, W61, W70, W71, W84, W85, W5, NW61
Electrical Upgrades: E55, W1, W4, W5, W51, W85, 62-64, NW61, W70, W71
Paint Program: All Dorms
Fire Alarm Upgrades: 62-64, NW61
Capital Projects in Construction Fiscal Year 2000 will be completed in Fall 2001
Housemaster's Apartment Renovation: W4, W71, W5

Select Fiscal Year 2001 Capital Planning Objectives
Desk Renovation: W84, W13
Roof Replacement: W85 Low-rise
Window Replacement: NW61 ongoing
Waterproofing/Pointing: E55, W4, W13, W51, W70, W84, W85 ongoing
Bathroom Renovations: 62-64, E55, W1, W4, W13, W51, W61, W70, W85 ongoing
Kitchen Renovations: W85, E55, W13, W51, W70, W4, W61, 62-64 ongoing
Plumbing/Mechanical Renovations: 62-64, E55, W1, W4, W13, W51, W61, W70, W71, W84, W85 ongoing
Electrical Renovations: 62-64, E55, W1, W4, W13, W51, W85, W70, NW61
Paint Program: All Dorms

New Capital Construction
RLSLP operational personnel have joined the Design Team for the new Graduate dorm, NW30 to assist with operational issues. In addition this staff continues to work with the Project Manager of the Undergraduate Dorm 2002 on similar operational issues.

Evening Operations
Evening Operations has been enhanced following review and testing of several options. Feedback from students and Housemasters resulted in staffing moves and changes that have benefited the overall evening operation. A new Evening Manager was hired to provide direction to this unit. In addition, training programs have been developed and implemented with Campus Police.

PERSONNEL CHANGES
Siobhain Blank was hired as House Manager of East Campus. Judy Brennan shifted from the role of Human Resource support to provide administrative and operational support to the Associate Director of Operations. Laura Capone was appointed to a new position as Assistant Director of Administration. Andy Eisenmann stepped down as Director at the end of the year. Loretta Hewitt was promoted to Manager of Graduate Housing. Shelly Anne Isaacs was hired as Administrative Assistant for Undergraduate Housing. Norma Lopez was hired as Program Coordinator for Student Activities. Julie Mills was hired as House Manager of Next House. Karen Nilsson was hired as Associate Director of Operations. Jon Nolan was hired as House Manager of Baker House, replacing Ken Winsor. Katie O'Dair will transition into a new role as Assistant Dean for Residential Programs, as Carol Orme-Johnson focuses on Student Conflict Resolution & Discipline. Linda Patton was assigned to Manager of Off-Campus Housing. Tracy Purinton was hired as the new Program Administrator for Student Activities. Marie Shanahan shifted her administrative assistant role from Housing to Student Life Programs. John Tocio retired as Manager of Dormitory Patrol. Laurie Ward replaced Edmund Jones as Staff Associate for Student Activities Finances. Ken Winsor was promoted to Evening Manager of Dorm Patrol.

More information about this department can be found on the World Wide Web at http://web.mit.edu/rlslp/.

Andrew Eisenmann

ROTC PROGRAMS

AIR FORCE RESERVE OFFICERS' TRAINING CORPS

We continue to recruit and commission men and women as second lieutenants in the United States Air Force.

Table 14. Year-end enrollment in AFROTC as of June 2000

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	13	6	3	13	35
Harvard	0	4	4	2	10
Tufts	0	1	0	0	1
Wellesley	0	0	0	2	2
Total	13	11	7	17	48

The academic year 1999–2000 at Detachment 365 at MIT has been exceptional. We had one distinguished graduate and two superior performers from field training summer 1999. In June 2000, we commissioned nine MIT graduates as Second Lieutenants. The academic year started with a memorable New Student Orientation (NSO) weekend in August 1999. New Student Orientation included not only field training part but also a Boston historical tour. The freshman had a great experience. The Civil Air Patrol Program, which we started last year, has been dynamite. We have eight cadets flying on weekends at Hanscom Air Force Base and they love it. In October 1999, 19 cadets traveled to Washington DC and visited the Capitol and the Pentagon. Over the weekend of 7 April 2000, the detachment visited the Gettysburg Battlefield for an on-site leadership seminar. Last year only eight cadets attended this event. This year we filled the bus and even had some Army ROTC cadets and cadre accompany us. In November, the detachment sponsored a Veterans Week Program. The week began with a tri-service POW/MIA Vigil at MIT. We also marched in the Boston Veteran's Day Parade. In November, we had a dining-in with former Secretary of the Air Force, Dr Widnall in attendance. The guest speaker was a Harvard Fellow who was the first B-2 squadron commander. In March 2000, we sponsored the MIT Tri-Service Military Ball. Retired General Gray, the former Commandant of the Marine Corps, was the speaker. Detachment 365 sponsored a New England field day for all Air Force ROTC units in the area. Det 365 at MIT won the competition beating U Mass at Amherst. U Mass at Lowell, WPI, and UNH.

There were two new initiatives this year. The three services developed a jointly taught leadership credit course with the Sloan School of Management. This 9-credit MIT course was taught in the fall of 1999. This is an exceptional opportunity to receive credit for ROTC courses. With the junior Leadership Course 15.305 and the senior National Security Management Course 17.471, AFROTC now has two for-credit courses in the MIT curriculum. Detachment 365 also developed a joint leadership seminar with the Sloan School of Management. ROTC and AFROTC taught this two-day non-credit course during IAP. Next year, I will be teaching a freshman seminar on leadership. The freshman seminar and mentor program is designed as a transitional program to help new students adjust.

For more information about our program, please visit our detachment web page at http://web.mit.edu/afrotc/www/.

John E. Kuconis

ARMY RESERVE OFFICERS' TRAINING CORPS

The purpose of the Army Reserve Officers' Training Corps (ROTC) is to provide instruction and training in military science subjects, to include a focus on leadership development. When coupled with the completion of a bachelor's degree, this training qualifies selected students for commissions as officers in the Active Army, Army Reserves, or Army National Guard.

The 1999–2000 Academic Year was successful in commissioning highly qualified graduates who promise to represent our program well. In March, the Secretary of the Army, the Honorable Louis Caldera, visited Harvard University and was given a briefing about Army ROTC by Lieutenant Colonel Rooney. The department received two prestigious awards: the Commanding General's Award for Training Excellence, awarded to the top 5% of the 270 programs across the nation; and the Order of the Founders and Patriots of America Outstanding Army ROTC Unit Award, presented to the best Army ROTC unit in the nation. The newly developed tri-service leadership and management course carrying a Sloan Course number was offered for the first time in the fall to all undergraduates. Again this year, Captain Cho co-directed a leadership seminar with Leaders for Manufacturing during IAP.

At the end of the academic year, 38 students were enrolled in our program. Of those 38 students 22 (58%) were minorities including 15 women (40%).

Table 15. Year-end enrollment in AROTC as of June 2000

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	5	4	1	0	10
Harvard	6	3	7	3	19
Wellesley	1	0	1	0	2
Tufts	2	2	0	3	7
Total	**14**	**9**	**9**	**6**	**38**

Of the ten enrolled MIT students, four are currently on scholarship, and an additional four were awarded scholarships this spring.

This year the Army ROTC commissioned 6 new second lieutenants. Four lieutenants will be reporting to Active Duty immediately. Two lieutenants received educational delays: one to medical school and one to law school.

Highlights for this year included a formal Military Ball, the Ranger Challenge held at Westover Air Reserve Base where MIT competed against 20 schools across New England, the Tri-Service Awards Banquet hosted by Army ROTC with 90 students receiving awards from 43 organizations, and the Pass In Review. Army ROTC supported the MIT Community Service Fund by participating in the 4-mile Road Race around the Charles River Basin. Tri-service commissioning ceremonies at Tufts, Harvard, and for MIT, at the *USS Constitution* were memorable events marking the transition from cadet to officer.

Off-campus learning opportunities continued to attract cadets who volunteered for training at Fort Benning, GA (Airborne School), West Point, NY (Air Assault School), and other U. S. Army Installations (Troop Leadership). Participation continued to be strong in the MIT Pershing Rifles Company, a group of both ROTC and non-ROTC students dedicated to the pursuit of excellence in military leadership and tactics.
Three faculty positions changed this year. Professor of Military Science Lieutenant Colonel Rooney retired from the service and was replaced by Major Brian L. Baker. Major Stor departed for Command General Staff College with no replacement named as yet. Captain Brown departed early in the school year and was replaced by Captain King.

More information about this department can be found on the World Wide Web at http://web.mit.edu/armyrotc/.

Brian L. Baker

NAVY RESERVE OFFICERS' TRAINING CORPS
The Naval Reserve Officers Training Corps (NROTC) program at MIT provides challenging and comprehensive leadership and academic training for students attending MIT, Harvard, and Tufts. The Program encourages academic achievement, while providing practical experience, to endow the Navy and Marine Corps with capable officers.

In the 1999–2000 Academic Year, a total of 13 graduating men and women were commissioned. Program enrollment just prior to June commencement was as follows:

Table 16. Year-end enrollment in NROTC as of June 2000

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	13	12	13	3	41
Harvard	8	1	6	6	21
Tufts	3	5	0	4	12
Total	24	18	19	13	74

The Navy's financial assistance for MIT students totaled $1,018,788 for the year. We are expecting approximately 19 new freshmen to enter the program this year.

The MIT midshipmen are involved in various activities throughout the year. Freshman Orientation is a week-long new student indoctrination held at the Naval Education and Training Center in Newport, Rhode Island. In the fall an annual formal ball was held to celebrate the birthdays of both the Navy and Marine Corps. The MIT NROTC Color Guard participated in the Boston Veteran's Day parade as well as several MIT football games. The midshipman battalion was also active in community service, including cleaning up several Cambridge parks. The MIT NROTC

sailing team hosted the Sixth Annual Beaver Cup Regatta on the Charles River where the team won second place. Midshipmen also participated in military excellence competitions at Villanova, Cornell, and Holy Cross.

During the summer, all of the scholarship midshipmen participate in active duty training with deployed naval units. This summer, midshipmen are cruising aboard submarines, maritime patrol aircraft, aircraft carriers, and amphibious assault ships, to name a few. This training provides invaluable experience for their future careers as naval officers.

The MIT NROTC unit hosted Rear Admiral Peter Long, Provost of the U.S. Naval War College, in the spring semester. Rear Admiral Long spoke to the unit about the future of the surface Navy and discussed principles of leadership with the midshipmen. The unit also hosted Commander Fritz Roegge, the Commanding Officer of the fast attack submarine, USS Connecticut. Commander Roegge spoke to the unit about the future of the submarine force and what it is like to be a submarine officer

The culmination of four years of training was reached on June 2, 2000, as three MIT students were commissioned as Ensigns in the United States Navy in a service alongside the USS Constitution. The guest speaker was Rear Admiral Jay M. Cohen, Chief of Naval Research.

More information about the Navy ROTC can be found on the World Wide Web at http://navyrotc.mit.edu/.

Captain Randall D. Preston

STUDENT FINANCIAL SERVICES

The mission of Student Financial Services is to enable students to meet their financial obligations while ensuring access for all qualified students without regard to their financial need. The five core business functions of Student Financial Services are: Bursar, Financial Aid, Loan Services, Student Services Center, and Student Employment.

BURSAR

Student Financial Services has responsibility for the Institute's bursar functions of billing and collecting tuition and related fees. Bursar highlights for fiscal year 2000 include the following:

- Serviced approximately 15,000 student accounts.
- Conducted 310,174 student account transactions.
- Recorded student tuition, fees and other charges of $291,999,387, an increase of 5.2% from fiscal year 1999.
- Received income from finance charges of $201,841 and from late payment fees of $246,362.

More information about the Bursar Department can be found on the World Wide Web at http://web.mit.edu/seo/.

FINANCIAL AID

Student Financial Services has responsibility for: development of financial aid policy; dissemination of financial aid information; counseling students and parents on financing an MIT education, applying for financial aid, and debt management; determining financial need; packaging financial aid awards; disbursing grants; administering federal, state, and private financial aid; and stewarding financial aid funds, including reporting to donors. The financial aid statistics for fiscal year 2000 are as follows.

In fiscal year 2000 2,312 undergraduates received a total of $50,275,512 in student financial aid, exclusive of student employment. This represents an increase of 2.5% from fiscal year 1999.

Undergraduate students were awarded scholarships and grants of $37,812,93, an increase of 5.0% from fiscal year 1999.

MIT Endowed Scholarships	$17,954,336
MIT Unrestricted Funds	$11,331,998
MIT Current Gifts	$ 1,587,735
Federal Supplemental Educational Opportunity Grants	$ 2,013,423
Federal Pell Grants	$ 1,108,185
Federal ROTC Scholarships	$ 402,622
Outside Scholarships	$ 3,414,632

Undergraduate students were awarded loans of $12,462,581, a decrease of 4.4% from fiscal year 1999.

Federal Direct Stafford/Ford Subsidized Loans	$ 6,459,905
Federal Direct Stafford/Ford Unsubsidized Loans	$ 682,999
Federal Perkins Loans	$ 3,375,093
MIT Technology Loans	$ 1,944,584

Graduate students were awarded loans of $14,287,49, a decrease of 2.3% from fiscal year 1999.

Federal Direct Stafford/Ford Subsidized Loans	$ 3,675,350
Federal Direct Stafford/Ford Unsubsidized Loans	$ 4,075,126
Federal Perkins Loans	$ 1,582,158
MIT Technology Loans	$ 4,954,865

Parents borrowed $9,484,715, an increase of 42.6% from fiscal year 1999.

Federal PLUS Loans	$ 2,826,214
MIT Parent Loan Plan	$ 2,430,220
Massachusetts Educational Finance Authority	$ 4,228,281

Total student borrowing by undergraduates and graduates was $26,750,080, a decrease of 3.3% from fiscal year 1999. Total borrowing by undergraduates, graduates and parents was $36,234,795, an increase of 5.6% from fiscal year 1999.

More information about Financial Aid can be found on the World Wide Web at http://web.mit.edu/seo/.

LOAN SERVICES

Student Financial Services disburses, bills and collects student and parent loans. Students borrow from three sources—the William D. Ford Federal Direct Loan Program, the Federal Perkins Program, and MIT's Technology Loan Program. Parents borrow from three programs—the Federal PLUS Loan Program, the MIT Parent Loan Plan, and the Massachusetts Educational Finance Authority. Student Financial Services is responsible for disbursing student and parent loans from all sources, and for collecting loans from the Federal Perkins Loan Program, MIT Technology Loan Program, and MIT Parent Loan Plan. In addition to these functions, Student Financial Services collaborates with the MIT Benefits Office to administer the MIT Educational Loan Plan for eligible employees.

Loan Services highlights for fiscal year 2000—beyond the financial aid statistics reported above—are as follows.

- Managed student loan receivable portfolio of $72,766,539 at year-end comprised of $21,523,927 in funds from MIT Loan Programs established by friends and alumni of the Institute, $29,919,986 in funds from the Federal Perkins Loan Program, and $21,322,626 in funds from Mass Bank.
- Completed fifth year of participation, fiscal year 2000, in the William D. Ford Federal Direct Loan Program with 17,471 cumulative loans totaling $89,784,905.
- Reconciled and completed closeout analysis for third year of participation, fiscal year 1998, in the William D. Ford Federal Direct Loan Program.
- Collected $3,681,749 in MIT's Federal Perkins Loan Program, resulting in continued low cohort default rate —estimated at 3.4% for fiscal year 2000.
- Moved loan servicing function for MIT's Parent Loan Plan in-house from Key Bank, thereby creating more flexible repayment options, enhancing customer service, and improving reporting.
- Collected $1,733,602 under the MIT Parent Loan Plan, resulting in a year-end receivable balance of $3,301,282.
- Working in collaboration with other MIT offices, disbursed $2,403,120 to MIT faculty and staff under the MIT Educational Loan Plan and collected $2,093,150, resulting in a year-end receivable balance of $2,519,886.

STUDENT SERVICES CENTER

Through the Student Services Center, Student Financial Services provides a broad range of academic, financial, and general customer services to students, parents, and alumni. Academic services include: obtaining an academic transcript, checking on grades, acquiring cross-registration information and materials, and receiving certification of enrollment. Financial services include: obtaining a financial aid transcript, talking to an account representative about the bill, signing loan promissory notes, making payments on the student account, talking to a financial aid officer about the financial aid award, receiving loan counseling, signing a scholarship check, receiving a student account refund, obtaining a copy of the financial aid statement, and obtaining a short term cash advance. General services

include replacing the MIT ID Card, changing or increasing the MIT MultiPlan, obtaining paper forms, and looking at job listings and filling out student employment forms.

Student Services Center highlights for fiscal year 2000 are as follows.

- Processed various forms (e.g., commencement applications, enrollment verification and transcript requests), provided documentation (e.g., Canadian tax forms, special bills and receipts), prepared refund checks and cash advances, and responded to queries such as how to access WebSIS, when to file financial aid applications, how to arrange medical leave of absence and where to send loan payments. Data derived in a 12-month period indicated that SSC staff answered 4,104 telephone calls, responded to 1,572 pieces of e-mail and answered 61,572 questions from students, parents, faculty, staff and visitors to MIT.
- Enhanced customer services by assuming distribution and collection of forms and applications previously distributed and collected by Academic Resources and Information Systems.
- Expanded services to include distribution of MIT Bulletin, previously distributed by the Information Office, thus increasing accessibility of academic information for prospective students and their families as well as MIT students cross-registered at Harvard, Wellesley, and the Massachusetts College of Art.
- Increased involvement with HASS program, providing students with expanded information about HASS requirements.
- Assumed more active role in Campus Preview Weekend, Parents Weekend and Orientation by providing prospective students, pre-freshmen and their parents with more staff availability through expanded hours and scheduled appointments.
- Increased knowledge of services provided by Campus Police in order to provide prospective students and their families with general information with respect to campus safety and security.

More information about the Student Services Center can be found on the URL from below.

STUDENT EMPLOYMENT

Student Financial Services creates and administers student employment opportunities for undergraduate and graduate students enrolled at the Institute, not just financial aid recipients. It also serves as the human resources office for students and their employers, on- and off-campus. MIT academic and administrative offices rely on Student Financial Services to assist them with personnel policies and procedures related to student employees.

The fiscal year 2000 student employment highlights are as follows.

- Increased employment opportunities for MIT students to over 1,500 job listings, including many positions at significantly higher pay rates than in prior years.
- Ended third year of participation in the Federal Work Study Community Service Program with an increase in the number of employers as well as employment positions.
- Created a new site, the Cambridge YMCA, during the third year of participation in the federal America Reads Program.
- Initiated participation in the federal America Counts program under which MIT students tutor math to elementary children grades 2-5.

More information about Student Employment can be found on the World Wide Web at http://web.mit.edu/seo/.

Elizabeth M. Hicks

NUMBER OF STUDENTS BY COURSE AND YEAR

FALL TERM 1999-2000 OFFICE OF ACADEMIC SERVICES

Course	Year 2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING												
Architecture, IV	13	20	22	-	55	167	34	26	1	228	283	IV
Urban Studies and Planning, XI	3	4	6	-	13	125	36	23	9	193	206	XI
Program in Media Arts and Sciences, MAS	-	-	-	-	-	66	65	-	1	132	132	MAS
Total	16	24	28	-	68	358	135	49	11	553	621	Total
SCHOOL OF ENGINEERING												
Aeronautics and Astronautics, XVI	59	37	33	1	130	130	67	2	7	206	336	XVI
Aeronautics and Astronautics, VI-C (Internship)	-	3	3	-	6	-	-	-	-	-	6	XVI-C
Chemical Engineering, X	82	84	83	3	252	54	144	1	1	200	452	X
Chemical Engineering, X-C	-	2	5	-	7	-	-	-	-	-	7	X-C
Civil and Environmental Engineering, I	-	-	-	-	-	179	88	4	6	277	277	I
Civil and Environmental Engineering, I-A	1	-	2	-	3	-	-	-	-	-	3	I-A
Civil and Environmental Engineering, I-C	5	9	13	1	28	-	-	-	-	-	28	I-C
Civil and Environmental Engineering, I-E	13	17	13	2	45	-	-	-	-	-	45	I-E
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-	-	-	-	8	-	-	8	8	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-	-	182	353	5	18	558	558	VI
Program 1 - Electrical Science and Engineering	46	36	42	8	132	-	-	-	-	-	132	VI-1
Program 2 - Electrical Engineering and Computer Science	215	146	97	9	467	-	-	-	-	-	467	VI-2
Program 3 - Computer Science and Engineering	101	104	117	12	334	-	-	-	-	-	334	VI-3
Electrical Engineering and Computer Science, VI-P (M.Eng.)	-	-	-	-	-	248	-	-	-	248	248	VI-P
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-	-	-	10	-	-	-	10	10	VI-PA
Program 1 - Electrical Science and Engineering	-	10	10	-	20	-	-	-	-	-	20	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	35	23	-	58	-	-	-	-	-	58	VI-2A
Program 3 - Computer Science and Engineering	-	16	15	-	31	-	-	-	-	-	31	VI-3A
Electrical Engineering and Computer Science, VI-W (Woods Hole)	-	-	-	-	-	2	2	-	-	4	4	VI-W
Materials Science and Engineering, III	26	5	8	-	39	78	78	-	15	171	210	III
Materials Science and Engineering, III-A	-	-	1	-	1	-	-	-	-	-	1	III-A
Materials Science and Engineering, III-B (Internship)	14	24	29	-	67	-	-	-	-	-	67	III-B
Materials Science and Engineering, III-C	-	1	-	-	1	-	-	-	-	-	1	III-C
Mechanical Engineering, II	102	97	90	17	306	220	161	-	1	382	688	II
Mechanical Engineering, II-A	4	8	7	2	21	-	-	-	-	-	21	II-A
Mechanical Engineering, II-B (Internship)	-	11	11	-	22	-	-	-	-	-	22	II-B
Nuclear Engineering, XXII	9	5	5	3	22	31	82	1	1	115	137	XXII
Nuclear Engineering, XXII-A (Internship)	-	-	2	-	2	-	-	-	-	-	2	XXII-A
Ocean Engineering, XIII	8	5	4	-	17	34	20	1	-	55	72	XIII
Ocean Engineering, XIII-W (Woods Hole)	-	-	-	-	-	4	16	-	-	20	20	XIII-W
Naval Construction and Engineering, XIII-A	-	-	-	-	-	26	-	-	-	26	26	XIII-A
Ocean Systems Management, XIII-B	-	-	-	-	-	6	-	-	-	6	6	XIII-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	-	5	45	-	-	50	50	BEH
Engineering Systems Division, ESD	-	-	-	-	-	104	17	1	1	123	123	ESD
System Design and Management, SDM	-	-	-	-	-	95	-	-	-	95	95	SDM
Total	685	655	613	58	2,011	1,408	1,081	15	50	2,554	4,565	Total

SCHOOL OF HUMANITIES AND SOCIAL SCIENCE												
Economics, XIV	31	20	36	6	93	1	101	19	1	122	215	XIV
Anthropology, XXI-A	-	-	1	-	1	-	-	-	-	-	1	XXI-A
Foreign Languages and Literatures, XXI-F	-	1	1	1	3	-	-	-	-	-	3	XXI-F
History, XXI-H	-	3	1	1	5	-	-	-	-	-	5	XXI-H
Literature, XXI-L	-	2	1	1	4	-	-	-	-	-	4	XXI-L
Music and Theater Arts, XXI-M	-	-	4	1	5	-	-	-	-	-	5	XXI-M
Writing and Humanistic Studies, XXI-W	1	-	2	2	5	-	-	-	-	-	5	XXI-W
Linguistics and Philosophy, XXIV	4	3	1	1	9	-	60	8	-	68	77	XXIV
Political Science, XVII	2	6	6	1	15	14	59	21	1	95	110	XVII
Program in Comparative Media Studies, XXI-CMS	-	-	-	-	-	5	-	-	1	6	6	XXI-CMS
Program in Science, Technology, and Society, STS	-	-	1	1	2	1	19	3	1	24	26	STS
Total	38	35	54	15	142	21	239	51	4	315	457	Total
SLOAN SCHOOL OF MANAGEMENT												
Management, XV	78	69	67	6	220	715	76	8	14	813	1,033	XV
Management Fellows, XV-A	-	-	-	-	-	57	-	-	-	57	57	XV-A
Operations Research, OR	-	-	-	-	-	16	35	-	-	51	51	OR
Total	78	69	67	6	220	788	111	8	14	921	1,141	Total
SCHOOL OF SCIENCE												
Biology, VII	73	95	103	5	276	1	195	3	1	200	476	VII
Biology, VII-A	-	-	5	1	6	-	-	-	-	-	6	VII-A
Biology, VII-W (Woods Hole)	-	-	-	-	-	2	31	1	-	34	34	VII-W
Brain and Cognitive Sciences, IX	33	28	20	4	85	2	44	3	1	50	135	IX
Chemistry, V	38	31	37	1	107	3	192	3	-	198	305	V
Earth, Atmospheric, and Planetary Sciences, XII	6	8	10	2	26	12	79	-	-	91	117	XII
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)	-	-	-	-	-	2	52	-	-	54	54	XII-W
Mathematics, XVIII	43	38	36	5	122	-	94	6	4	104	226	XVIII
Mathematics with Computer Science, XVIII-C	16	15	6	2	39	-	-	-	-	-	39	XVIII-C
Physics, VIII	36	37	25	8	106	9	229	3	2	243	349	VIII
Physics, VIII-A	5	12	1	-	18	-	-	-	-	-	18	VIII-A
Total	250	264	243	28	785	31	916	19	8	974	1,759	Total
WHITAKER COLLEGE of Health Sciences and Technology												
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	-	5	276	-	10	291*	291*	HST
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	-	-	64	64	64	CAES
Undesignated Sophomores	11	-	-	-	11	-	-	-	-	-	11	UND
First Year	-	-	-	-	1,055	-	-	-	-	-	1,055	First Year
Special Undergraduate -- No Course	-	-	-	-	8	-	-	-	-	-	8	Special-NC
Grand Total	1,078	1,047	1,005	107	4,300	2,611	2,758	142	161	5,672	9,972	Grand Total
Not included in above totals:												
Foreign Study: 9 students in the third year, and 7 students in the fourth year.												
Non-Institute Brandeis, NIR	-	-	-	-	-					3	3	NIR
Non-Institute Harvard, NIH	11	21	35	-	79					220	299	NIH
Non-Institute Tufts, NIT	9	-	5	-	17					-	17	NIT
Non-Institute Wellesley, NIW	19	19	51	-	89					-	89	NIW
Non-Institute Research Visitor, NIV	-	-	3	-	3					52	55	NIV
Non-Institute Exchange, NIE	-	-	7	-	7					10	17	NIE
Total	39	40	101		195					285	480	Total

*Number includes 181 students working on Harvard degrees only.

NUMBER OF DEGREES AWARDED

		S.B.	S.M.	M.Arch, MCP M.Eng, MBA	Engineer	PhD	ScD	Total
SCHOOL OF ARCHITECTURE								
	Architecture	-	-	19	-	8	-	27
	Architecture Studies	-	22	-	-	-	-	22
	Art and Design	23	-	-	-	-	-	23
	Building Technology	-	2	-	-	-	-	2
	Media Arts and Sciences	-	26	-	-	13	-	39
	Media Technology	-	5	-	-	-	-	5
	Planning	7	-	-	-	-	-	7
	Real Estate Development	-	36	-	-	-	-	36
	Urban Studies and Planning	-	2	58	-	9	-	69
	Visual Studies	-	4	-	-	-	-	4
Total		30	97	77	-	30	-	234
SCHOOL OF ENGINEERING								
	Aeronautics and Astronautics	33	48	5	2	18	1	107
	Chemical Engineering	87	8	-	-	46	-	141
	Undesignated	10	-	-	-	-	-	10
	Chemical Engineering Practice	-	29	-	-	-	-	29
	Civil Engineering	14	-	-	-	-	-	14
	Civil and Environmental Engineering	-	47	47	1	13	-	108
	Undesignated	2	-	-	-	-	-	2
	Computer Science and Engineering	185	-	-	-	-	-	185
	Electrical Science and Engineering	78	-	-	-	-	-	78
	Electrical Engineering and Computer Science	124	70	189	2	78	4	467
	Engineering and Management	-	59	-	-	-	-	59
	Environmental Engineering Science	14	-	-	-	-	-	14
	Logistics	-	-	16	-	-	-	16
	Materials Science and Engineering	38	22	-	-	19	2	81
	Undesignated	3	-	-	-	-	-	3
	Mechanical Engineering	104	105	-	1	24	2	236
	Undesignated	9	-	-	-	-	-	9
	Naval Architecture and Marine Engineering	-	7	-	-	-	-	7
	Naval Engineer	-	-	-	6	-	-	6
	Nuclear Engineering	11	14	-	1	5	2	33
	Ocean Engineering	3	11	-	-	4	-	18
	Ocean Systems Management	-	3	-	-	-	-	3
	Technology and Policy	-	41	-	-	1	-	42
	Technology, Management and Policy	-	-	-	-	3	-	3
	Toxicology	-	4	-	-	2	-	6
	Transportation	-	14	-	-	-	-	14
Total		715	482	257	13	213	11	1,691

SCHOOL OF HUMANITIES AND SOCIAL SCIENCE								
	Economics	56	4	-	-	23	-	83
	Foreign Languages and Literatures	2	-	-	-	-	-	2
	Humanities	1	-	-	-	-	-	1
	Humanities and Engineering	5	-	-	-	-	-	5
	Humanities and Science	4	-	-	-	-	-	4
	Linguistics	-	2	-	-	4	-	6
	Linguistics and Philosophy	1	-	-	-	-	-	1
	Literature	8	-	-	-	-	-	8
	Music	8	-	-	-	-	-	8
	Philosophy	3	-	-	-	4	-	7
	Political Science	8	7	-	-	10	-	25
	Science, Technology, and Society	-	2	-	-	4	-	6
	Writing	2	-	-	-	-	-	2
Total		98	15	-	-	45	-	158
SLOAN SCHOOL OF MANAGEMENT								
	Management	-	47	360	-	13	-	420
	Management Science	71	-	-	-	-	-	71
	Management of Technology	-	49	-	-	-	-	49
	Operations Research	-	9	-	-	8	-	17
Total		71	105	360	-	21	-	557
SCHOOL OF SCIENCE								
	Atmospheric Science	-	1	-	-	-	-	1
	Biology	115	1	-	-	27	-	143
	Undesignated	21	-	-	-	-	-	21
	Brain and Cognitive Sciences	25	2	-	-	6	-	33
	Chemistry	34	-	-	-	22	-	56
	Climate Physics and Chemistry	-	2	-	-	-	-	2
	Earth and Planetary Sciences	-	2	-	-	-	-	2
	Earth, Atmospheric, and Planetary Sciences	10	-	-	-	9	-	19
	Geosystems	-	7	-	-	-	-	7
	Mathematics	88	2	-	-	16	-	106
	Mathematics with Computer Science	10	-	-	-	-	-	10
	Physics	36	9	-	-	39	-	84
Total		339	26	-	-	119	-	484
WHITAKER COLLEGE of Health Sciences and Technology								
	Health Sciences and Technology	-	-	-	-	8	1	9
	Medical Informatics	-	2	-	-	-	-	2
Total		-	2	-	-	8	1	11
Without Course Specification		-	31	-	-	-	-	31
Awarded Jointly with Woods Hole Oceanographic Institution:								
	Biology	-	1	-	-	7	-	8
	Civil and Environmental Engineering	-	1	-	-	-	-	1
	Earth, Atmospheric, and Planetary Sciences	-	2	-	-	14	1	17
	Electrical Engineering and Computer Science	-	-	-	-	2	-	2
	Ocean Engineering	-	1	-	1	3	-	5
Grand Total		1,253	763	694	14	462	13	3,199

NUMBER OF WOMEN STUDENTS BY COURSE AND YEAR

FALL TERM 1999-2000 — OFFICE OF THE REGISTRAR

Course	Year 2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING												
Architecture, IV	10	11	16	-	37	69	20	17	1	107	144	IV
Urban Studies and Planning, XI	2	1	5	-	8	60	16	11	5	92	100	XI
Program in Media Arts and Sciences, MAS	-	-	-	-	-	20	14	-	1	35	35	MAS
Total	12	12	21	-	45	149	50	28	7	234	279	Total
SCHOOL OF ENGINEERING												
Aeronautics and Astronautics, XVI	19	12	10	-	41	24	11	-	2	37	78	XVI
Aeronautics and Astronautics, VI-C (Internship)	-	1	-	-	1	-	-	-	-	-	1	XVI-C
Chemical Engineering, X	53	46	47	1	147	19	36	1	-	56	203	X
Chemical Engineering, X-C	-	1	2	-	3	-	-	-	-	-	3	X-C
Civil and Environmental Engineering, I	-	-	-	-	-	48	27	-	2	77	77	I
Civil and Environmental Engineering, I-A	1	-	1	-	2	-	-	-	-	-	2	I-A
Civil and Environmental Engineering, I-C	2	3	8	1	14	-	-	-	-	-	14	I-C
Civil and Environmental Engineering, I-E	10	10	7	2	29	-	-	-	-	-	29	I-E
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-	-	-	-	2	-	-	2	2	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-	-	40	58	-	2	100	100	VI
Program 1 - Electrical Science and Engineering	12	10	15	2	39	-	-	-	-	-	39	VI-1
Program 2 - Electrical Engineering and Computer Science	56	34	21	1	112	-	-	-	-	-	112	VI-2
Program 3 - Computer Science and Engineering	18	20	24	2	64	-	-	-	-	-	64	VI-3
Electrical Engineering and Computer Science, VI-P (M.Eng.)	-	-	-	-	-	53	-	-	-	53	53	VI-P
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-	-	-	1	-	-	-	1	1	VI-PA
Program 1 - Electrical Science and Engineering	-	4	-	-	4	-	-	-	-	-	4	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	10	7	-	17	-	-	-	-	-	17	VI-2A
Program 3 - Computer Science and Engineering	-	1	4	-	5	-	-	-	-	-	5	VI-3A
Electrical Engineering and Computer Science, VI-W (Woods Hole)	-	-	-	-	-	-	1	-	-	1	1	VI-W
Materials Science and Engineering, III	17	2	3	-	22	22	17	-	7	46	68	III
Materials Science and Engineering, III-B (Internship)	7	19	18	-	44	-	-	-	-	-	44	III-B
Materials Science and Engineering, III-C	-	1	-	-	1	-	-	-	-	-	1	III-C
Mechanical Engineering, II	32	31	31	4	98	41	11	-	-	52	150	II
Mechanical Engineering, II-A	1	4	3	1	9	-	-	-	-	-	9	II-A
Mechanical Engineering, II-B (Internship)	-	1	4	-	5	-	-	-	-	-	5	II-B
Nuclear Engineering, XXII	4	2	5	2	13	6	17	-	1	24	37	XXII
Nuclear Engineering, XXII-A (Internship)	-	-	1	-	1	-	-	-	-	-	1	XXII-A
Ocean Engineering, XIII	4	1	2	-	7	5	2	-	-	7	14	XIII
Ocean Engineering, XIII-W (Woods Hole)	-	-	-	-	-	1	3	-	-	4	4	XIII-W
Naval Construction and Engineering, XIII-A	-	-	-	-	-	1	-	-	-	1	1	XIII-A
Ocean Systems Management, XIII-B	-	-	-	-	-	1	-	-	-	1	1	XIII-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	-	3	28	-	-	31	31	BEH
Engineering Systems Division, ESD	-	-	-	-	-	31	3	1	-	35	35	ESD
System Design and Management, SDM	-	-	-	-	-	12	-	-	-	12	12	SDM
Total	236	213	213	16	678	308	216	2	14	540	1,218	Total

SCHOOL OF HUMANITIES AND SOCIAL SCIENCE												
Economics, XIV	19	13	17	2	51	-	27	6	-	33	84	XIV
Anthropology, XXI-A	-	-	1	-	1	-	-	-	-	-	1	XXI-A
Foreign Languages and Literatures, XXI-F	-	1	1	1	3	-	-	-	-	-	3	XXI-F
History, XXI-H	-	2	1	-	3	-	-	-	-	-	3	XXI-H
Music and Theater Arts, XXI-M	-	-	1	1	2	-	-	-	-	-	2	XXI-M
Writing and Humanistic Studies, XXI-W	-	-	2	1	3	-	-	-	-	-	3	XXI-W
Linguistics and Philosophy, XXIV	4	2	-	-	6	-	30	-	-	30	36	XXIV
Political Science, XVII	2	2	3	1	8	6	22	9	1	38	46	XVII
Program in Comparative Media Studies, XXI-CMS	-	-	-	-	-	2	-	-	1	3	3	XXI-CMS
Program in Science, Technology, and Society, STS	-	-	1	1	2	-	8	-	1	9	11	STS
Total	25	20	27	7	79	8	87	15	3	113	192	Total
SLOAN SCHOOL OF MANAGEMENT												
Management, XV	38	32	24	2	96	186	21	1	1	209	305	XV
Management Fellows, XV-A	-	-	-	-	-	12	-	-	-	12	12	XV-A
Operations Research, OR	-	-	-	-	-	-	8	-	-	8	8	OR
Total	38	32	24	2	96	198	29	1	1	229	325	Total
SCHOOL OF SCIENCE												
Biology, VII	51	57	74	2	184	-	94	2	1	97	281	VII
Biology, VII-A	-	-	3		3	-	-	-	-	-	3	VII-A
Biology, VII-W (Woods Hole)	-	-	-	-	-	2	17	-	-	19	19	VII-W
Brain and Cognitive Sciences, IX	20	17	18	2	57	1	14	-	-	15	72	IX
Chemistry, V	24	17	20	-	61	1	72	-	-	73	134	V
Earth, Atmospheric, and Planetary Sciences, XII	4	6	6	2	18	4	25	-	-	29	47	XII
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)	-	-	-	-	-	-	35	-	-	35	35	XII-W
Mathematics, XVIII	20	16	12	1	49	-	23	1	2	26	75	XVIII
Mathematics with Computer Science, XVIII-C	10	3	1	-	14	-	-	-	-	-	14	XVIII-C
Physics, VIII	6	8	4	3	21	1	24	-	-	25	46	VIII
Physics, VIII-A	2	-	-	-	2	-	-	-	-	-	2	VIII-A
Total	137	124	138	10	409	9	304	3	3	319	728	Total
WHITAKER COLLEGE of Health Sciences and Technology												
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	-	2	74	-	1	77	77	HST
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	-	-	7	7	7	CAES
Undesignated Sophomores	5	-	-	-	5	-	-	-	-	-	5	UND
First Year	-	-	-	-	452	-	-	-	-	-	452	First Year
Special Undergraduate -- No Course	-	-	-	-	4	-	-	-	-	-	4	Special-NC
Grand Total	453	401	423	35	1,768	674	760	49	36	1,519	3,287	Grand Total

DEAN FOR GRADUATE STUDENTS

DEVELOPMENT OF STRATEGIC COMMUNICATION AND BUSINESS STRATEGIES

For the past year, the GSO has continued its strategic collaboration with the Communications Office to develop new business and communications strategies for graduate education at the Institute. This has been time consuming and often tedious work, as we have undertaken detailed exercises to re-examine and re-define fundamental business objectives, opportunities and options for reaching our most important customers, and desired outcomes for all of our efforts. Barrie Gleason, Director of Communications has been "on loan" to the GSO at 25% time for the past year, to assist with this work. Her insights and structured activities have been invaluable in moving our analysis forward.

We have questioned many closely held assumptions about who our customers are, what they need to hear, and how we deliver both services and information to them. This analysis has helped us to identify a number of crosscutting themes that have provided the framework for a set of specific business objectives for the coming year and for a number of immediate action steps to pursue those objectives. Each step along the way resulted from an enormous amount of background work by Barrie Gleason and Associate Dean Blanche Staton, leading to a series of critical meetings with the Dean and other collaborators. Invariably, these meetings have crystallized our vision and have led to new and productive business interactions with Admissions, Career Services, Alumni, Resource Development, Student Services, the Publishing Services Bureau, and other offices. Collectively, these relationships are already redefining the visibility and impact of the Graduate Students Office, and are shaping ways in which we will conduct our business in the future. For GSO staff, this is nothing short of a revolution in how we think about our professional relationships with other operations at MIT and how they work with us towards mutually beneficial objectives, many of which were never identified or pursued before. What we and our collaborators have begun to realize is that by working together in specific ways, no one is relinquishing oversight or responsibility. Rather, our combined efforts have been defining and achieving both currently understood and newly defined objectives. This is analogous to having captured fireflies in a bottle and combining their individual lights into a brighter illumination.

In addition to the growing number and depth of collaborations spawned by our work, to be described more fully below, we have moved forward aggressively to articulate key messages about graduate education at MIT. Barrie Gleason, Dean Staton, and Dean Colbert have met with representatives from six academic departments; and Ms. Gleason and Dean Staton have held a series of focus group discussions with various graduate student interest groups. We are planning with the Alumni Association to have similar discussions in the coming academic year with groups of recent alumni/ae. These discussions have been effective in promoting new thinking about graduate students and community at MIT, so effective that we have decided to extend the series of meetings to include the remaining academic departments.

As this work moves towards its completion, it has benefits for the Institute, for the Communications Office and for the Graduate Students Office. For the Institute, this work is crystallizing a model for collaborative leadership across many administrative operations, and the active collaborations with the GSO are demonstrating the power of the approach. This work is also promoting and contributing to the growing awareness of "graduate community" at MIT and requirements for its success. Finally, the GSO is poised to build a new generation of communication resources to help departments attract graduate students and to better support their presence in this community.

For the Communications Office and related operations, this work is defining a new area of business that can be exported to other departments and operations at MIT. A suite of analytical tools and processes is being developed that can help others to examine, modify, and rebuild communications and business strategies in a coherent manner. It seems most likely that this approach will work best when promoted by a senior officer, who can ensure that his or her organization understands the depth of commitment at the top to a comprehensive overhauling of business priorities and communication strategies.

The value for the Graduate Students Office is obvious. We will have defined a new vision and new priorities for our business and our customers, will have developed a coherent set of messages that will be appropriate Institute-wide, and will have effected new and more effective business collaborations with other administrative operations. When this work has been substantially completed in the coming year, the Graduate Students Office should be able to field publications, key messages, and critical services that are timely and that are appropriately tuned to each of our customers.

Through the successful efforts of the past year, the GSO has a good idea of what the key messages about graduate education should be, and has defined business priorities associated with our major publications and web presence.

The Publishing Services Bureau will be a critical collaborator and resource for the next phase of work, along with colleagues who are helping to develop a detailed information mapping for graduate education.

COLLABORATION WITH OTHER AREAS

As business strategies have been examined and re-prioritized, opportunities for collaborative work with other administrative operations have developed in the past year. During this period, the GSO initiated twelve such efforts. Some have been short-term projects that were begun and completed, while the most intensive efforts will require a detailed specification of desired outcomes and careful cost justification.

Short-term Projects

Celebrating Graduate Women

On April 4 a first-of-its-kind event was held in Building E15, to celebrate the presence and contributions of graduate women at MIT. Co-sponsored by the GSO, the MIT Women's League, and the Spouses and Partners Group, this very successful event attracted at least 275 participants, comprised of 235 students, 11 faculty and 11 senior administrators and luminaries. The event provided a singular opportunity to contribute to a sense of community by promoting networking among women at MIT. Those in attendance were asked to give feedback about which existing GSO services they value, and to identify new services they would appreciate.

Graduate Degree Listing

At the request of the Communications Office, the GSO and the graduate administrator group collected, reviewed and revised the first comprehensive listing since 1983 of graduate degrees offered by Institute departments and programs. This seemingly simple task proved far more complex than anticipated, since many departments had not officially reviewed their degree specifications in years. The final list will be published in Fall 2000 as a part of the MIT Bulletin.

Workshops and Seminars

A variety of informational workshops, meetings and seminars were held with Disabilities Services, the Graduate Administrators Roundtable, and the Graduate Student Council. These activities were focused on developing better understanding of the GSO's business and communication opportunities with respect to these groups.

A Letter to Recent Graduate Alumni/Alumnae

The Alumni Association and the Resource Development Office worked with the GSO to experiment with a new fund raising approach focused on graduate students who have completed their degrees within the past six years. The objective was to encourage giving for institutional-level goals in addition to traditional gifts to departments and laboratories. A letter from Dean Colbert to recent graduate-degree holders stressed themes relevant to graduate community at MIT and emphasized several mechanisms by which this constituency can direct gifts towards those objectives. Few, if any, universities have pursued graduate alumni/ae for giving in this manner. If this initial effort yields promising results, then the Institute may have opened a new avenue for alumni development. The timing of this initiative seems propitious, since the Institute is in the process of increasing housing available to graduate students and is moving rapidly to build and strengthen graduate students' sense of community. Success in these areas might generate greater allegiance to the Institute and enhance future prospects for graduate participation in alumni affairs and giving.

Support to Libraries for University Microfilms Transition

During the past year, the costs to graduate students to archive thesis abstracts with Dissertation Abstracts International rose from $25 to $50 in January 1999. As of January 2000, it rose again to $55. The Libraries have subsidized most of the abstracting fee for the students since 1990, but with increasing difficulty due to budget constraints. Passing the increased fee on to students was inevitable, but the GSO agreed to mitigate the impact by providing a one-time $1,500 subsidy to the Libraries.

Strategic Collaboration Projects

Graduate Information Landscape

Work began this past year on a major business priority that requires close collaboration with ODSUE IT, the Publishing Services Bureau, and the graduate administrators. The "Information Landscape" project seeks to provide detailed descriptors of the content of GSO publications and the relationships among them. In the analytical phase of this work, a crosscutting team deconstructed each section of the Graduate Education Manual, the Practical Planning Guide and other GSO publications. We examined content, clarity of presentation, responsibility for maintenance of the material, and the relationship of each section's content to other sections and to other know publications around

MIT. Ultimately, each section will be incorporated into a publishing database that will permit us to organize information flexibly into an infinite range of publications, each tailored to a specific audience or purpose.

In the coming year, we expect to complete the information mapping, define several targeted publications, and begin producing a new and more focused set of marketing and recruiting materials.

Graduate Women's Group

Two years ago, a collaborative effort was started between Counseling and Support services and the GSO to provide a support group for graduate women. In the past year, that effort developed into the bimonthly Graduate Women's Group. Each lunchtime discussion is facilitated jointly by the Associate Dean for Graduate Students and the Program Administrator in Counseling and Support Services, and has a theme that is determined by participants based on their needs, issues and concerns. This past spring, the GSO sponsored a one-day retreat at Endicott House, facilitated by a member of the Consulting and Training Team. The focus of discussion was on creating a repertoire of practical and results oriented approaches to communication in difficult situations.

Graduate Admissions Database

Plans were discussed with the Admissions Office to add a number of data fields to the admissions database. These fields would comprise contact information from GSO recruitment visits around the nation, which is now collected and maintained in a local database in the GSO. Before undertaking this project, a backlog of existing work needed to be closed out. Therefore, the GSO underwrote costs for an additional programmer for the spring term 2000 to assist in completing the work and paving the way inclusion of data fields requested for our recruitment needs. We anticipate that these accommodations will be in place for the fall 2000 recruitment season.

Alumni/Alumnae Association

In a series of discussions with staff from the Alumni Office, the GSO reviewed its hopes for improved and expanded communication with MIT graduate alumni and alumnae. Conversations produced a number of action items, including letters to this group from Dean Colbert, from President Vest and from departments. Plans were made to create a series of focus-group discussions with active alumni/ae clubs nationally and internationally, seeking their views about graduate education at MIT and how it appears to be marketed.

Publishing Services Bureau

Discussions were begun to define a range of print and web based projects to address specific GSO business priorities for the 2000–2001 year.

Resource Development

The GSO articulated goals and objectives for the campaign with regard to graduate fellowships. A number of specific messages were incorporated into draft campaign literature for the graduate fellowship project. Going forward, plans were made to meet on a regular basis throughout the coming year with the Director of Communications, to keep informed or ongoing work and to provide the GSO with opportunities to contribute to campaign activities.

OFFICE OPERATIONS

With support and encouragement from management, both GSO professional and support staff have benefited from MIT's training and development program. Staff members took courses to enhance job-related skills and competencies in areas such as SAP usage, computer literacy, collaborative leadership, and meeting facilitation. Additionally, staff cross training was initiated to produce a more flexible and adaptive for task completion and achievement of business objectives.

New practices were designed and implemented to provide better in-office documentation of financial transactions, including new forms to describe GSO funded student activities and improved forms to explain more fully details of certain business transactions.

PROGRAMS AND SERVICES FOR GRADUATE STUDENTS

Power Lunch

This monthly series of luncheon seminars is designed to promote the academic, professional and personal development of students of color. It also provides an opportunity for students from diverse academic departments to develop supportive peer relationships, to share experiences, insights and strategies for managing the challenges of graduate work. In the past year, the GSO identified a broad range of presenters to share their expertise with the

students. Among these were speakers on financial planning, business start-up, preparing for doctoral qualifying examinations, building a professional support network, managing stress, and negotiating conflict.

Graduate Women's Group

Two years ago, a collaborative effort between the Associate Dean for Counseling and Support Services and the Associate Dean for Graduate Students began. Its objective was to provide a supportive community for graduate women, and began with a series of lunch meetings for graduate women. Participation doubled during the past year, with an average of 15 women attending biweekly lunch discussions held throughout the academic year. Each discussion centers on a theme determined by t he students and based on their needs, issues and concerns. Activities culminated in a one-day retreat at Endicott House to develop strategies to address several ongoing concerns. A member of MIT's Performance Consulting and Training Team facilitated the retreat.

Welcoming Receptions for New Graduate Women and for Students of Color

The GSO continued its tradition of sponsoring receptions to introduce new graduate women and new students of color to their peers and to acquaint them with critical resource offices, individuals and programs. The receptions promote networking, reduce perceptions of isolation, and identify sources of support.

Guest Speaker

In February, The GSO brought Dr. Grace Carroll to MIT for a 2-day visit, which included a book talk and several small-group seminars. This initiative was a response related to a number of race- related concerns expressed by graduate students of color. Referencing her recently published book, *Environmental Stress and African Americans: The Other Side of the Moon*, Dr. Carroll discussed race as a stress factor for students and offered a variety of coping strategies.

Graduate Women's Book Club

The GSO's financial support of this club, whose members emerged from the Graduate Women's Group, is one expression of the office's mission to enhance the cultural experience of graduate students. The club began with 3 or 4 students sharing books as a way of minimizing their expense. However, that approach limited the number of students who could participate and reduced the frequency of meetings. By underwriting the cost to acquire books, the GSO removed the financial obstacle, and participation in the club immediately tripled. At the end of the academic year, about 15 women were gathering at 2 to 3 month intervals to discuss and critique books of various genres, build friendships, and share ideas.

PROGRAMS AND SERVICES FOR UNDERGRADUATE STUDENTS

The GSO continues to support student life in the broadest sense by committing resources to various undergraduate activities. This past year, the office provided funding for 14 events and activities. Moreover, GSO administrators and staff are called upon routinely to serve informally as academic, pre-professional and career advisors.

GRADUATE FELLOWSHIPS OFFICE

The Fellowships Office serves as the local fiscal agent for a wide variety of Federal, foundation, corporate, and individual or family funds in support of graduate students. The largest of these resources continue to be the National Science Foundation Fellowship (NSF), the National Defense Science and Engineering Education Grant (NDSEG) and the Howard Hughes Medical Institute (HHMI) award. During the past year, the two government-based fellowships supported 298 active fellows, with an additional 70 on reserve status. The HHMI supported 51 of these active fellows.

The chart below summarizes NAF trends at MIT for the past five years:

Academic Year	Number of Active Fellows
1995–1996	248
1996–1997	262
1997–1998	247
1998–1999	259
1999–2000	263

In the past year, the Fellowships Office was delegated administrative responsibility for the GEM Fellowship (National Consortium for Graduate Degrees for Minorities in Engineering and Science), which is the nation's largest provider of graduate funding for Master's Degree programs. Additionally, the Fellowships Office administers the newly initiated Ford Foundation and Ford Motor Company Fellowship Fund, which exposes students to the Ford professional environment and the excitement of the practice of engineering and manufacturing.

A controversy arose this past year with the Hertz Foundation over the issue of supplemental support for Hertz Fellows. Foundation support for its fellows consists of a $25,000 stipend and a modest tuition allowance that produces a significant shortfall. Some departments provide partial research assistantships to cover the entire shortfall, while others structure supplemental support to require students tot pay a portion of the shortfall from the stipend income. In objecting to that latter practice, the Hertz Foundation sought to eliminate differences among departments in how its fellowship would be administered. In the end, the Foundation agreed that each department can continue to use its internal standards to determine the maximal level of stipend income, but that incoming Hertz Fellows would be told in advance about departmental policies.

The annual Tax Workshop for citizens and permanent residents was again sponsored by the GSO and held during late February. Led by Frederick I. Crowley of the Comptroller's Accounting Office, the workshop continues to be a timely and valuable service to graduate students in helping them to understand and meet their tax obligations.

The GSO, in collaboration with the Teaching and Learning Laboratory (TLL), again cosponsored the annual Orientation Workshop for Graduate Teaching Staff. Held at the beginning of the Fall Term, the workshop encourages and supports graduate teaching effectiveness. It provides opportunities for new and continuing graduate teaching assistants to better understand the complexities of their responsibilities, and gives them practical advice about a range of issues that they will face in their teaching assignments.

INTERNATIONAL STUDENTS OFFICE

The mission of the International Students Office is to help the international student population at MIT fulfill their academic goals by providing services and support programs which facilitate their adjustment to the new academic and cultural environment. The Office assists students in maintaining their legal status in the United States, provides support for their dependents, and promotes their interaction with and integration into the MIT community at large. In addition, the ISO interfaces with all MIT offices, advocating for awareness in the Community of issues salient to the MIT International Student.

Federally mandated legislation drove much of the agenda in the ISO during the 1999–2000 year. While the ISO continued its routine work with respect to legal admission, orientation, advising. and programming for the international student, all efforts were set against the backdrop of the impending implementation of the Coordinated Interagency Partnership Regulating International Students (CIPRIS) program. (The CIPRIS program is part of an omnibus immigration bill passed by Congress and signed by President Clinton in 1996.) CIPRIS will require International Offices to track and electronically report specific data to the Immigration and Naturalization Service (INS) on a regular basis. With CIPRIS in mind, the ISO petitioned Information Systems for new computer hardware and in late January managed to secure four new G-4 Macintosh computers for the office. The upgrade has made it possible to begin the process of re-building the ISO database for more efficient data collection and INS forms production. In March, the ISO submitted a proposal to ODSUE IT (now known as Student Services Information Technology) to evaluate, fund and undertake the ISO Database Project so that MIT's ISO will be able to track international students and provide required data and reports to the INS. This project was approved by the Provost's Office, and currently Phase One, which has evaluated ISO needs, MITSIS access requirements, and CIPRIS mandates, is near completion. When this project comes to fruition some time in the summer of 2001, the ISO will have the ability to comply with government mandates. In addition, an integrated database will also allow the ISO to streamline and even eliminate some of its more routine, labor intensive tasks, thereby affording the Office the ability to expand and improve the services outlined below.

The ISO continues to play a pivotal role in the legal aspects of Admissions which enables International students admitted to MIT to secure their visas, arrive in a timely fashion, and be both culturally and legally oriented to life in the US and at MIT. The sheer volume of our admissions work increased quite dramatically in 1999–2000. We had an overall increase in enrollment numbers from 2,198 to 2,386. (See chart attached) And this number does not include our exploding number of Visiting Students and Special Students, which increased to approximately 100 over the course of the year. Admissions has become technically more complex over the past two years with the expanding number of new academic programs and alliances which specifically target international students. The Systems Design Management program, for example, is particularly appealing to international companies. Tuition rates and physical participation in the SDM program, however, are not uniform as they depend upon the agreements with individual employers. The Masters of Engineering Programs, which have been popular with internationals, have added another layer of complexity in our efforts to streamline admissions processes. MIT's early forays into the Distance Learning arena also poses current and future immigration hurdles. As every new program and alliance has its own admission idiosyncrasies, the ISO has become proficient in applying legal admissions requirements to new

realities. Having the assistance of Carlene Green (the staff we have shared with the department of Electrical Engineering and Computer Sciences over the past five years), in addition to having the entire ISO staff knowledgeable about Admission processing, has made it possible to deal with the expanding variety and scope of MIT academic programs which admit foreign nationals.

Advising remains at the core of the ISO's responsibility to the MIT International Student. Thousands of students have received advice on immigration procedures and regulations for travelling, employment, change of visa status, etc. By individual appointment, as well as through the use of our increasingly more sophisticated web-site and e-mail, prospective students, admitted students, current students, and graduated students (who seek our counsel long after commencement!), the three advisors have been kept busy providing legal and personal advice. While ostensibly seeking ISO expertise because INS regulations require it, students also come to the ISO with underlying concerns about cultural adjustment and worries about political tensions back home. In this important advising role, the ISO is a place to seek technical information, clarification, advice, comfort, and even protection. Among our international students this year, we have seen a distressing and significant increase in cases involving mental health issues, domestic violence, and academic dishonesty. International Advisors have needed to hone their knowledge of Institute policy and resources with respect to these areas, while being mindful of the Immigration dilemmas they present. As in the past, advisors have continued to visit students who have been hospitalized, comfort students grieving the loss of a loved one back home, and intervene, on behalf of troubled students, with immigration and consular officials.

All international students, regardless of age, degree program, or familiarity with life in the US, undergo a period of cultural adjustment. They, and their dependents, require information about their new surroundings, culture, and community. This year for the first time, we have devoted a special section of our web-site to incoming international students and their families. We continue to refine it on a weekly basis. Through the extensive use of the Web and e-mail, incoming students are now able to address many of their practical concerns prior to arrival to the US. We will be evaluating the efficacy of this new service with our incoming students in the fall. Once students arrive on campus, we have provided individual and small group orientation sessions to ALL incoming internationals, daily from mid-August to September. The ISO is, in fact, legally required to provide immigration information to all new students and to verify that they are in appropriate legal status. We have expanded this mandated orientation to include overall orientation to Boston and MIT culture. Complementing our required orientation, were a number of social events open to the entire international community. These events included Coffee Hours, presentations by the Medical Department, the Libraries, the Campus Police and culminated with an International Student Panel, a Faculty Panel, and the International Open House. For two years running now, the ISO has been solely responsible for Undergraduate International Orientation. The ISO staff and international upperclassmen worked together this year to welcome new students with events such as a pancake breakfast, a Boston "Duck" Tour, an international barbecue and a cross-cultural workshop. We hope to secure funding to augment this type of programming in the future.

The Host to International Students Program (HISP) has remained vital in providing new students with supportive emotional and social ties to the MIT community. Kate Baty, the Coordinator of the program, has been tireless this year in her efforts to develop and implement new programs and events. In addition to the traditional Welcome Picnic for new students and their host families, Kate and the ISO staff organized potluck dinners for students and host families, which encouraged and solidified cross-cultural relationships within the MIT community. Kate continued to be actively involved with the Mentor Program, which matches incoming international freshman with upperclassmen before they arrive. The relationship develops between student and mentor, with airport pick up and a bevy of social activities and mentor-organized programming during the first month after arrival. The Mentor Program has been staffed and organized entirely by volunteer students, along with volunteer co-founder Paulette Schwartz. As we begin the second year of the program, we have found that the original protegees provide the Program with a pool of committed mentors for the new incoming class, a true testament to the success of the program. The ISO will seek ways, financial and other, to support and expand this invaluable initiative. In the coming year, we plan to explore the feasibility of a mentor program for graduate international students.

The ISO continued to offer and sponsor workshops of special interest to MIT International Students during IAP. Options for internships and employment in the US have always been of great concern. Danielle Guichard-Ashbrook presented two workshops covering the laws that regulate the employment of F-1 and J-1 student visa holders as they relate to jobs at MIT, summer internships off-campus, and work possibilities after graduation. An Immigration attorney and labor law attorney with start-up company expertise presented a workshop that highlighted the legal, practical, and ethical issues involved in starting a company in the US. A prominent Boston area immigration attorney presented an informative talk on future visa options when student visa eligibility ends. MIT's Assistant

Controller, Fred Crowley, once again presented a critical workshop about federal and state tax filing requirements for international students. All of these IAP workshops were extremely well attended, and some even oversubscribed. Next year, the ISO hopes to use the IAP period to organize and provide programming for internationals around the difficult, yet very important issues of academic dishonesty and domestic violence.

Personnel

In December 1999, Milena Levak retired as Director and Associate Dean of the ISO. Since that time Danielle Guichard-Ashbrook has been the Acting Director and Associate Dean. Maria Brennan has doubled her efforts to undertake some of the Assistant Dean responsibilities. In January, the ISO hired Elizabeth Singh, a recent graduate of the Lesley School of Intercultural Relations, as a 6-month temporary International Student Advisor. She will be replaced in August 2000 by another one-year temporary hire. After the management of the ISO is established, a permanent Advisor will be hired to bring us to our full compliment of International Advisors in the Office. Kate Baty has ably continued as Host Family Coordinator and has also taken on the unheralded role of non-immigration advising to many undergraduate internationals. Mina Xanthopolis continued as our Senior Staff Assistant, but announced her resignation in late June 2000. Carlene Green, our half year support staff will replace her and come aboard as a full-time staff member in July 2000. A new temporary worker, Anita Di Marco, is filling in as our much-needed receptionist and has quickly acquired some basic immigration knowledge. The ISO intends to advocate strongly that the receptionist be made a permanent position on the staff. Following an eight month vacancy, the I SO hired Andrew Wang as a professional Technical Support Specialist in February 2000. Andrew has been absolutely critical in the negotiations with the Student Services Information Technology team regarding the ISO Database Project and meets weekly with the IT consulting group overseeing the project. As a member of the ISO staff, he will do much of the programming and beta testing of the new database at each stage of implementation. Andrew has also re-vamped our web-site in the short time he has been on board, adding new features and targeting specific groups of our population. He will continue to look for ways to make technology work for the ISO.

Professional Activities and Awards

The ISO staff continued to be regionally and nationally recognized by their colleagues in the field. At the November Regional NAFSA Conference in Rhode Island, Kate Baty received an Outstanding Service award to acknowledge her many years of selfless service to the international community. Danielle Guichard-Ashbrook was selected to present, along with a criminal defense attorney, a session entitled, " Crimes and Misdemeanors: International Students In Trouble with the Law!" at the Regional Conference. At the Spring Immigration Workshop at the University of New Hampshire, Maria Brennan presented for the first time. She was part of a team giving a workshop on basic F-1 student regulations. At the National NAFSA Conference in San Diego, Danielle chaired and presented an all-day workshop in advanced student regulations to over 150 international advisors and directors from across the country and Canada. She was part of a team of three who developed the curriculum for this workshop which in now the national model for all workshops of this type. For these efforts, she was recognized nationally with a Distinguished Service Award, presented to her in San Diego.

Student Recruitment Activities

Over the past year, the GSO's recruitment efforts have included travel to 15 states and Puerto Rico. During these travels, over 27 schools were visited, and 4 major conferences attended, ensuring MIT's visibility as an institution seeking the best students for its graduate programs.

Recruitment efforts included graduate school fairs, school visits and information booths at national meetings and conferences. This year, 10 schools that had not been visited in the past several years were added to the recruitment schedule, thus re-establishing ties and expanding our recruitment network. Among these schools were several Historically Black Colleges and Universities (HBCU) and universities within the Hispanic Alliance of Colleges and Universities (HACU) where MIT alumni and alumnae are either faculty or administrators. Also included were four universities in Massachusetts and Rhode Island. MIT was represented by the GSO at several conferences including those sponsored by the National Society of Black Engineers (NSBE) in Charlotte, NC; the National Minority Research Symposium (NMRS) in Phoenix, AZ, which includes the MARC and MBRS national scholars programs; the Society of Hispanic Professional Engineers (ShiPE), in Washington, DC; and the National Action Council for Minorities in Engineering (NACME), in Orlando, FL. Each conference offered MIT opportunities to reach the most talented undergraduates in technical and research fields, as well as opportunities to interact with faculty and administrators from their institutions.

Two external recruitment efforts were new last year, the NSF/Minority Graduate Education (MGE) Northeast Alliance and the Ford-MIT-HBCU Initiative. The NSF/MGE effort partners Boston University, Pennsylvania State

University, Rutgers University and the Amherst campus of the University of Massachusetts with several predominantly minority institutions. Participating universities are Jackson State, Lincoln, Long Island, Medgar Evers, and the University of Puerto Rico-Mayaguez. Working collectively, the Alliance hopes to increase the number of students from participating schools who enroll in doctoral programs in New England. The Ford initiative shares the graduate education objective, but has a more proprietary long-term interest in convincing more minorities to consider a career with Ford. HBCU's involved in this program include Clark Atlanta University, Florida A&M, Hampton, Howard, Tennessee State, Tuskeegee, Morehouse College, and Spelman College.

The GSO continues to see growing departmental interest in additional efforts to actively recruit all students, especially minorities and women. Several departments have conferred with GSO staff about approaches to which they might contribute. Among those discussed have been direct faculty participation in recruitment trips, involvement of selected departmental representatives in important national meetings, and collaboration with the Summer Research Program (MSRP) to identify and sponsor summer interns.

MIT Summer Research Program

Summer 1999 marked the 14th consecutive year of the program, with 31 participants. Two participants were "guests" of the program, having been identified and recruited solely through departmental efforts. Interns conducted research in 12 departments and centers, with 28 faculty members volunteering to serve as mentors. Similarly, collaboration with the Center for Innovation in Product Development (CIPD) that began in 1998 continued to provide summer research experience for a number of interns. In that collaboration, the CIPD absorbed all program costs.

By the end of the academic year, six past participants of the MSRP had been admitted to graduate programs at MIT, a number equal to that of the prior year. We are delighted that the MSRP continues to be successful in encouraging interns to matriculate into graduate science and engineering programs. We are even more delighted that MIT has admitted more than 12% of those who have participated.

Isaac M. Colbert

WOMEN, FOREIGN NATIONAL AND MINORITY GRADUATE ENROLLMENT, AY 1974 TO AY 1999

Academic Year	# Women	% Women	# Foreign National	% Foreign National	# Minorities	% Minorities	Total Enrollment
1974	318	9.5%	954	28.4%	121	3.6%	3,358
1975	405	11.7%	970	28.0%	151	4.4%	3,468
1976	487	13.5%	1,037	28.8%	155	4.3%	3,603
1977	546	14.5%	1,059	28.1%	178	4.7%	3,774
1978	559	14.6%	1,151	30.1%	157	4.1%	3,824
1979	606	15.4%	1,145	29.0%	147	3.7%	3,944
1980	684	16.5%	1,219	29.4%	150	3.6%	4,146
1981	779	17.8%	1,283	29.3%	174	4.0%	4,384
1982	828	18.2%	1,347	29.7%	140	3.1%	4,541
1983	856	19.1%	1,418	31.6%	145	3.2%	4,489
1984	914	19.7%	1,439	31.1%	143	3.1%	4,631
1985	981	20.6%	1,449	30.5%	141	3.0%	4,757
1986	981	19.9%	1,658	33.7%	139	2.8%	4,920
1987	987	19.8%	1,497	30.1%	144	2.9%	4,979
1988	929	19.2%	1,441	29.8%	154	3.2%	4,832
1989	963	20.0%	1,498	31.1%	159	3.3%	4,822
1990	1,064	21.7%	1,628	33.2%	168	3.4%	4,909
1991	1,092	22.0%	1,674	33.7%	155	3.1%	4,967
1992	1,155	23.0%	1,711	34.1%	190	3.8%	5,019
1993	1,177	23.4%	1,755	34.9%	215	4.3%	5,024
1994	1,154	22.7%	1,744	34.3%	193	3.8%	5,090
1995	1,308	23.9%	1,798	32.9%	229	4.2%	5,465
1996	1,313	23.8%	1,745	31.6%	285	5.2%	5,518
1997	1,354	24.6%	1,842	33.5%	268	4.9%	5,499
1998	1,394	25.3%	1,857	33.7%	266	4.8%	5,513
1999	1,512	27.0%	2,001	35.7%	206	3.7%	5,608
TOTALS	**24,346**	**20.1%**	**38,320**	**31.6%**	**4,573**	**3.8%**	**121,084**

GRADUATE STUDENT ENROLLMENT, FALL 2000

	Internationals	Women	*Minority	**Non-Resident	**Total MIT Enrollment**
School of Architecture and Planning	194	234	23	49	**553**
Architecture	93	107	7	26	228
Media Arts and Sciences	38	35	4	0	132
Urban Studies Planning	63	92	12	23	193
School of Engineering	901	540	97	15	**2,554**
Aeronautics and Astronautics	89	37	9	2	206
Chemical Engineering	58	56	9	1	200
Civil and Environmental Engineering	151	79	11	4	285
Electrical Engineering and Computer Science	186	155	36	5	820
Materials Science and Engineering	75	46	4	0	171
Mechanical Engineering	159	52	18	0	382
Nuclear Engineering	53	24	4	1	115
Ocean Engineering	43	13	2	1	107
ESD, SDM, BEH	87	78	4	1	268
School of Humanities and Social Science	136	113	8	51	**315**
Economics	64	33	3	19	122
Linguistics and Philosophy	39	30	2	8	68
Political Science	28	38	2	21	95
Science, Technology and Society	5	9	1	3	24
Comparative Media Studies	0	3	0	0	6
School of Management (w/Operations Rsch)	411	229	38	8	**921**
School of Science	317	319	30	19	**974**
Biology	21	116	6	4	234
Brain and Cognitive Science	21	15	0	3	50
Chemistry	66	73	13	3	198
Earth, Atmospheric and Planetary Sciences	41	64	1	0	145
Mathematics	62	26	0	6	104
Physics	106	25	10	3	243
Whitaker College	42	77	10	0	**291**
Total Graduate Enrollment	**2,001**	**1,512**	**206**	**142**	**5,608**
Category as % of Total	36%	27%	4%	3%	

* "Minority" refers to underrepresented groups: African Americans, Mexican Americans, Native Americans, Other Hispanics and Puerto Ricans.
** "Non-resident" refers to students who are in non-resident doctoral dissertation status.

VICE PRESIDENT AND DEAN FOR RESEARCH

The areas that report to the Vice President and Dean for Research include the departments in the Whitaker College, and the interdisciplinary laboratories, centers, and programs. At the beginning of FY2000 the Intellectual Property Office became a part of the Office of the Vice President and Dean for Research.

The Vice President and Dean for Research continues to sponsor annual seminars on research practice aimed at clarifying the range of acceptable practices in conducting research. These seminars bring together faculty, professional research staff, postdoctoral associates and fellows, and graduate students to discuss topics such as mentorship, authorship, and secrecy in science. They are moderated by Dr. Stephanie Bird, Special Assistant to the Provost and participation is Institute-wide by invitation.

PERSONNEL CHANGES

Effective January 1, 2000, Professor Daniel Kleppner became Interim Director of the Research Laboratory of Electronics. Effective January 1, 2000, Ms. Danielle Ashbrook-Guichard became Acting Director of the International Students Office. Mr. Jack Turner became Associate Director of the Technology Licensing Office in April, 2000.

More information about this organization can be found on the World Wide Web at http://web.mit.edu/vpr/www/.

J. David Litster

WHITAKER COLLEGE

The Whitaker College of Health Sciences and Technology (Whitaker College) is a major interdisciplinary academic and research entity at MIT. Several areas of research and teaching that are pertinent to health, both fundamental and applied, have been developed and been incorporated into Whitaker College.

Current activities in the Whitaker College include the Harvard/MIT Division of Health Sciences and Technology, the Clinical Research Center, the Center for Environmental Health Sciences, and the Division of Comparative Medicine.

More information about this organization can be found on the World Wide Web at http://web.mit.edu/vpr/www/whitaker.html

J. David Litster

CENTER FOR BIOMEDICAL ENGINEERING

The mission of the Center for Biomedical Engineering (CBE) is to combine engineering with molecular and cellular biology to develop new approaches to biomedical technology and to foster research in the rapidly growing discipline of Biological Engineering. With five new members this past year, over 45 CBE faculty (from departments in the MIT Schools of Engineering and Science, as well as the Whitehead institute, Harvard and Boston University Medical Schools, and the Harvard-MIT Division of Health Sciences and Technology) carry out interdisciplinary, multi-investigator research programs within CBE. This faculty research provides a training environment for a new generation of graduate and undergraduate students in Bioengineering, at the interface between Engineering and Biology.

To accomplish this mission, a major focus this past year has been the further development of state-of-the-art core facilities, and a novel Engineering/Biology Seed Grant Program in collaboration with CBE's Industrial Advisory Board. The Core Facilities have been crucial in establishing new multi-investigator collaborations with Harvard Medical School affiliated Hospitals, including a Core Center in Musculoskeletal Diseases focusing on Orthopaedic Gene Therapy and Tissue Engineering, involving 35 investigators from MIT and Harvard, and a collaborative Program in Mechanotransduction In Cardiovascular Cells, focusing on basic research in mechanical regulation of cellular response, with direct application to cardiovascular disease.

Among the many outstanding research accomplishments by CBE faculty this past year, new developments in neural tissue engineering have emerged based on a novel self assembling peptide scaffold biomaterial. This emerging technology has resulted in a broad spectrum of biocompatible materials through molecular engineering, which have been used to encapsulate cells such as neurons and chondrocytes. The ongoing DARPA Program in Vascular Tissue Sensors for Generic Toxin and Pathogen Detection, involving 13 Co-Pis, has produced critical advances which have been leveraged, in part, by CBE's Multi-Photon Microscopy facility.

ENGINEERING/BIOLOGY SEED GRANT PROGRAM

CBE's Engineering/Biology Seed Grant Program continues to act as a catalyst for such multidisciplinary collaborations, funded by members of CBE's Industrial Advisory Board. CBE's next Industrial Advisory Board meeting will occur this coming Fall 2000, at which students and faculty will present oral and poster presentations summarizing their latest research.

The 1999–2000 Seed Grant awards funded projects on:

- Collagen-Glycosaminoglycan Matrices As Vehicles For Delivery of Genes for Articular Cartilage Regeneration (Myron Spector, Brigham and Womens Hospital, Ionnis Yannas, MIT, Chris Evans and Bjorn Olsen, Harvard Medical School, with the objective to development novel biopolymer constructs, using native extracellular matrix macromolecules, for use in gene delivery; with application to cartilage diseases and cartilage repair);
- Platforms for Enhancing Biomolecular Analysis by Desorption/Ionization Mass Spectrometry (Paul Laibinis and Steven Tannenbaum, MIT, Paul Matsudaira, Whitehead Institute, with the objective to develop methods and semiconductor nanoparticles for improved matrix assisted laser desorption/ionization (MALDI) mass spectrometry for quantitative visualization and identification of peptides, nucleotides, sugars, and other biomolecules);
- Actin polymerization-driven motility: Rocket propulsion in Listeria monocytogenes (L. Mahadevan, MIT and Tim Mitchison, Harvard Medical School, with the objective to quantify the molecular biophysical mechanisms and mechanochemistry of polymerization driven cellular machines associated with cell migration and with infection mechanisms of pathogens such as Listeria);

- Chondrocyte Migration for Cartilage Wound Repair and Tissue Engineering (D. Lauffenburger, MIT and Teresa Morales, Harvard Medical School, with the objective to study the conditions and mechanisms by which chondrocytes may be induced to migrate on 2-dimensional substrates and subsequently through cartilage matrix, with application to cartilage repair).

NEW FACILITIES

This past year, CBE has developed additional state-of-the-art multi-user core facilities for use by undergraduate and graduate students and faculty. In addition to Multi-Photon Imaging and Atomic force Microscopy, a new Cryofixation, Freeze-Fracture/Deep Etch facility is now housed in Room 56-367, comprising two devices: a Leica EM-CPC plunge slam freezer and a Cressington CFE-60 Freeze Fracture System. The combination of these two pieces of equipment will allow users to bring tissue specimens, cell cultures, cell-seeded scaffolds, or other hydrated biomaterials to the facility and take away a dimensionally stable platinum/carbon replica of the cryopreserved ultrastructure as revealed by the fracture plane (etched or unetched). The replica will be suitable for viewing on high-resolution transmission electron microscopy. Applications include resolving ultrastructural details of extracellular matrix, scaffold and gel matrices, cell membranes, and intracellular ultrastructure, and can be extended to include histochemical identification of individual matrix/cellular components if combined with techniques such as immunogold labelling. These methods will enable microstructural characterization of tissue engineering matrices and scaffold materials at the submicron level, which is critical to understanding cell-material interactions.

More information about this Center can be found on the World Wide Web at http://web.mit.edu/cbe/www/.

Alan J. Grodzinsky

CENTER FOR ENVIRONMENTAL HEALTH SCIENCES

For the last twenty years the Center for Environmental Health Sciences has tried to discover if the chemicals or radiation in our environment are responsible for causing the genetic changes which cause human diseases especially cancers. The major hypothesis/dogma of this field was that environmental chemicals were metabolized to chemically reactive intermediates, reacted with the DNA and, failing the action of DNA repair systems, were miscopied at DNA replication to create heritable mutations. These environmentally–induced mutations included those necessary for human diseases such as cancer and atherosclerosis.

However, research in our Center has produced observations that directly challenge the importance of environmentally induced mutations. Three separate studies have yielded observations comparing smokers' and nonsmokers' lungs which are wholly inconsistent with the idea that cigarette smoking increase risk of lung cancer by increasing the rate of point mutations in the bronchial epithelium from which most lung tumors arise.

- In 1998 CEHS published its findings that mitochondrial mutations are the same in number and kind in the lungs of smokers and nonsmokers. Identical twins discordant for cigarette smoking showed no differences in mitochondrial mutations. It was necessary to develop a technology to allow scanning of a portion of the mitochondrial genome to be able to detect mutations at frequencies as 1/million gene copies.
- Now we have determined the same thing is true of nuclear mutations. Five point mutations in the nuclear genes P53, K-RAS and HPRT occur in hundreds of small colonies of about 128 each in each lung obtained at autopsy and microdissected for mutation assays. Work still in progress indicates that any differences between lungs of smokers and nonsmokers, if statistically significant, are too small to account for the effect of cigarette smoking on lung cancer risk.
- CEHS entry into the field of epidemiology has led to creation of a publicly accessible database for mortality in the United States from 1900 and for Japan from about 1950. [http://cehs4.mit.edu] To use these data to estimate the historically changing parameters that may explain shifts in population cancer experience, a unified field model has been developed and applied to a series of cancers. Estimates of the rates of initial mutations in historical periods and populations differing widely in age-specific cancer risk indicate that these mutation rates are historically invariant and also invariant between American and Japanese populations. Analysis of human lifetime lung cancer mortality rates for American birth year cohorts from 1850 to the present day indicates that cigarette smoking does not significantly increase the rate of early genetic changes required to create tumors. The data suggest that cigarette smoking creates an environment in which many more precancerous adenomas survive in smokers' than in nonsmokers' lungs.

One major CEHS program grant, the Superfund Basic Research Program has been studying the nearby Aberjona River Basin and its residents for some fifteen years. A second is the program grant, "Mutagenic effects of Air-borne Toxicants," in which we sought to test the hypothesis that urban air pollution represented an increased risk for lung cancer. Both have been funded via the National Institute of Environmental Health Sciences (NIEHS). Our new approach to analysis of public health records led us to re-examine the widely held assumptions that the town of Woburn, MA, home to two Superfund Sites, had a statistically higher experience of pediatric leukemia and that this

was due to exposure to a contaminated public water supply. We organized the age-specific mortality data for all towns and cities in Massachusetts and created a model for the expected distribution of deaths from each major disease observed in the past thirty years. We discovered that the distribution of deaths from pediatric leukemia was consistent with variations among communities due to chance alone. The town of Woburn was fifth highest among Massachusetts communities lying well within the distribution expected for chance variation. We further found that the distribution of death rates for all diseases save lung cancer was consistent with differences due to chance alone. The statistically significant difference for lung cancer was explained by the significantly higher measured prevalence of cigarette smoking in cities as compared to towns and villages.

We next compared mortality rates among towns comprising or immediately downstream from Superfund Sites with all other towns without any known local cache of chemical contaminants. There were no differences between these two groups of towns for any form of mortality. These studies are now being extended to the populations of Pennsylvania, New York, Illinois, California, Texas and Florida comprising some 44% of all deaths in the United States since 1968.

These findings, both by direct measurements of genetic change in human organs or by organizing and analyzing public mortality data, may be considered positively in terms of the natural progress of science inexorably discovering former error. But they have also created a great deal of discomfort among scientific reviewers of CEHS' proposals and even the committee that decides whether or not we can submit program proposals to NIEHS. This discomfort is acute and has created an immediate hiatus in CEHS' funding. For instance, after we reported our basic findings regarding urban pollution, cigarette smoking and lung cancer to NIEHS we were refused permission to submit a competitive renewal proposal after 22 years of funding and the enthusiasm of five successive site visit teams for peer review. The total rejection of our analyses of the leukemia situation in Woburn and our conclusion that the presence of Superfund Sites had no effect on mortality rates in Massachusetts led to rejection of our competitive renewal proposal for the Superfund Basic Research Program. These two programs comprised more than 2/3 of CEHS research support.

To overcome the funding problems and build upon the solid accomplishments of our faculty we have reorganized to create a Center in which faculty explore various organs in the human body to discover what biological changes could be affected by environmental agents and create higher cancer risks.

- We have enlisted the participation of Professor Ian Hunter (Mechanical Engineering) to design and develop nanotechnolgy to permit automated microdissection of human tissues for analyses of changes in gene expression, extracellular matrices, exposure to exogenous and endogenous agents and all forms of genetic change. With these toxicology faculty should be able to explore phenomena hypothetically related to disease progression in cancer, atherosclerosis and other diseases increasing as a population ages. A first proposal in this area has already been submitted to NIH and others are being prepared.
- We have benefited from the leadership of Dr. Helmut Zarbl in creating a world-class center for mRNA array analyses at the Fred Hutchinson Cancer Research Center in Seattle. The capabilities of our former MIT colleague's group reduces human genome wide scanning to less than $250 per "chip" and should permit highly competitive proposals testing hypotheses about environmental stresses and expression of gene ensembles.
- We have enlisted the collaboration of Professor Stephan Morgenthaler of the ETH, Lausanne and Professor Kari Hemminki of the Karolinska Institute, Stockholm to "beef up" our growing efforts in analyses of public health records. A three-institution grant proposal has already been submitted to NIH to analyze the age specific cancer risks for first degree relatives of cancer patients.

Importantly the defunct NIEHS research program has been accepted as a new program grant proposal by the National Cancer Institute where our novel findings have struck a responsive chord. Both NCI and we believe that smoking is the clearest case of an environmental factor increasing cancer rates and that an orderly series of hypotheses such as we have presented should be tested.

CEHS is in the midst of hard times with respect to research funding but is also experiencing an exciting scientific renewal possibly defining its worth as an MIT level organization. Let us hope financial recovery precedes our institutional demise.

More information about this center can be found on the the World Wide Web at http://web.mit.edu/cehs/index.html.

CLINICAL RESEARCH CENTER

The Clinical Research Center (CRC) was established in 1964, with grant support from the National Institutes of Health (NIH), to provide a facility in which Massachusetts Institute of Technology (MIT) investigators and their collaborators could apply the Institute's expertise in basic biochemical and biophysical mechanisms to the analysis of normal and pathologic processes in humans. MIT's CRC was the first federally supported clinical research center

located in a university and not within a hospital, and remains one of only two or three such centers. It was anticipated that in spite of its university venue, a large number of qualified physicians and clinical scientists from MIT's faculty and staff would utilize the CRC to study normal volunteers, or patients with chronic diseases.

Scientists and physicians authorized to carry out research protocols using the CRC's facilities include: professors; research scientists who work exclusively at MIT; and those with primary appointments in local medical institutions whose research interests overlap extensively with those of MIT investigators. Research protocols must be approved by the MIT Committee on the Use of Humans as Experimental Subjects (COUHES) and the CRC Advisory Committee before they can be implemented. The CRC Advisory Committee, chaired by Dr. Daniel Shannon, Professor of Pediatrics at the Harvard Medical School and Professor of Health Sciences at the Harvard/MIT Division of Health Sciences and Technology, consists of eleven voting members plus nine non-voting members from the CRC's program staff. The Committee reports to the Principal Investigator of the CRC's NIH Grant, Martha Gray, Professor and Co-director of Harvard/MIT Division of Health Sciences and Technology (HST); it meets bimonthly to evaluate protocols for their scientific quality, experimental design, ultimate statistical validity, and potential risk to human subjects. The Committee also sets general policies and reviews the operations of the CRC.

ADMINISTRATION

The CRC presently has a dual administrative locus within MIT. As a research unit, the CRC reports through the Harvard-MIT Division of HST to the Vice President and Dean for Research, Professor David Litster. However as a patient-care unit, the CRC is a part of the MIT Medical Department and reported to Dr. Arnold Weinberg, the Director of the Medical Department. Members of the CRC participate in the Medical Department activities; e.g., its Quality Improvement, Pharmacy and Therapeutics, Medical Records, and Safety Committees.

Several years ago the CRC was approached by the General Clinical Research Centers administration of the NIH, which funds this and all other CRC's, and asked to consider becoming a "Network" CRC. This would involve implementing at the MIT CRC some research projects generated at other local CRC's, and, conversely, implementing some of the projects (e.g., those involving very sick patients) at those other centers. Additi onally, the CRC would, where possible, coordinate the activities of the core laboratories, nutrition programs, and nursing programs with those of other local institutions, in order to increase their efficiency. The CRC would also use this networking as a platform from which to solicit additional NIH funds, perhaps as a part of a common grant.

Initially, the CRC extensively explored setting up a primary relationship with the CRC at the Beth Israel-Deaconess Medical Center (BIDMC). However, in spite of excellent intentions and a strong mutual desire that collaborations expand, no research protocols generated at that institution or MIT ever were implemented at the other center. The CRC then began to explore a more structured relationship with the CRC at the Massachusetts General Hospital (MGH), and this expanding relationship has, in fact, been highly successful. To date fifteen MGH protocols have been approved and implemented at the MIT CRC, and three MIT protocols have been implemented at the MGH. The senior program staffs at the two institutions have been meeting monthly to anticipate and solve potential problems related to their gradual integration and to streamline the protocol review process; COUHES and its MGH counterpart also work together to evaluate network protocols from the standpoint of safety.

To date, 15 MGH projects have been approved and initiated at MIT; three projects conducted by MIT investigators are being conducted at both sites. The relationship between the two CRCs will continue to be developed and expanded, and the two centers will formally submit a joint NIH renewal grant application, for five years of support, to start funding in December 2002, when the present NIH grant expires. Meanwhile, since the present MIT grant expires a year earlier (2001), the MGH and we will, in the next year, jointly submit an application for year of funding for the MIT CRC as a dedicated supplement to the MGH grant. We will thereafter be identified as a "Satellite" to the MGH CRC, but will suffer no loss of "sovereignty" or autonomy nor, based on discussion with the NIH, no decrease in funding.

Developing this type of "network" relationship with the MGH CRC allows the CRC to solve a chronic problem, i.e., the small and shrinking pool of medical doctors conducting clinical research in this facility, a consequence of the failure, during the last decade, of MIT's academic departments to appoint such people as professors. Most important, it guarantees the longevity of the CRC until such time as the pool again expands, and provides a source of physician scientists to collaborate with MIT biomedical scientists who hold doctoral degrees. The reputations of the two CRC's apparently are excellent, and the strengths of each institution complement those of the other. The CRC also continues to "network" with other Boston-area GCRC's (e.g., BIDMC) and all interested parties agree that the CRC should continue to do so in the future.

EDUCATION

The CRC provides opportunities for training in clinical research to regular MIT and HST students and fellows. These fellows and students utilize the CRC's facilities to initiate research protocols and to participate in ongoing projects supervised by senior investigators and faculty. (See section on the Center for Experimental Pharmacology and Therapeutics)

AFFIRMATIVE ACTION

The hiring of women and minorities continues to be a high priority commitment of the CRC. The CRC does have one continuing problem in meeting affirmative action objectives; i.e., in attracting qualified minority members. The traditional means of locating them, by advertising and posting positions in local colleges, universities, medical institutions, and minority organizations have not generated a significant response.

This past year one research staff position became available; a male minority was hired. All four Visiting Scientists appointed in 1999-2000 were women. The CRC will continue its efforts to increase the pool of qualified minority applicants, as positions become available.

RESEARCH ACTIVITIES

The CRC continues to maintain major commitments to the research activities associated with three clinical areas, and to involve three groups of scientists, each led by a senior professor. These areas are: *Nutrition/ Metabolism* (Vernon R. Young, professor, MIT School of Science), an area in which the CRC constitutes the major locus of MIT's activity, and one that is a traditional component of clinical research centers; *Neurochemistry/Neuropsychopharmacology* (Richard J. Wurtman, Cecil H. Green Distinguished Professor and Program Director, MIT CRC), studies on the effects of drugs, foods and hormones on brain composition and behavior; studies on melatonin and sleep, and on biologic rhythms in sleep and hormone secretion; studies on a set of diseases characterized by affective and appetitive symptoms (i.e., depression, premenstrual syndrome, smoking withdrawal, carbohydrate craving, obesity), which seem to relate to brain serotonin; and *Behavioral Neuroscience* (Suzanne Corkin, Professor of Brain and Cognitive Sciences), focusing on the effects of diseases on cognitive and related brain functions and on genetic and other mechanisms causing neurodegenerative disorders (e.g., Alzheimer's disease). Groups collaborate on multi disciplinary projects, e.g., obesity; depression; Alzheimer's disease. However, the scope of its activities has expanded broadly: In the past year it also supported research protocols involving, for example, toxicology, pediatrics, psychopharmacology, women's health, HIV, biomedical engineering, diabetes, and neuroendocrinology. Reflecting its evolving interactions with the MGH GCRC, 15 of these projects (out of a total of 45) were directed by investigators whose primary appointments are at the MGH.

This year the CRC patient census totaled 100 inpatient days and 1181 outpatient visits. The CRC branch of the NIH had provided, based on prior years' activities, support for up to 295 inpatients and 3906 outpatient visits. The decreased census could be explained by the completion of the data-gathering portions of several large projects.

CENTER FOR EXPERIMENTAL PHARMACOLOGY AND THERAPEUTIC

The HST Center of Experimental Pharmacology and Therapeutics (CEPT), based in the MIT CRC, has both an educational and research mission. This Center is directed by Dr. Robert Rubin, (HST), Osbourne Professor of Health Sciences and Technology. Educationally, each year 10 MD's who have completed their clinical training enter a two-year program that provides both "hands-on" research experience and didactic training in clinical investigation and experimental pharmacology. At the end of the two years, after passing a qualifying examination and fulfilling a thesis requirement, the graduates receive a Master/Medical Science degree in clinical investigation from HST. A parallel program for Ph.D. scientists is in the process of being established as well. This will involve HST, the Sloan School, the Department of Biology, and the School of Engineering, and will again be centered in the CRC. Research-wise, the emphasis of the CEPT has been in the application of positron emission tomography, magnetic resonance imagery, ultrasound and other measurement technologies to the development of new drugs. With the development of imaging at MIT, these efforts will be greatly facilitated, starting in the coming year.

COMPUTER FACILITY

The CRC computer staff continued to develop the CRC Operations System with the addition of systems for the Core Laboratory and the Dual Energy X-ray Absortiometry facility (DEXA). These systems use an ORACLE relational database, and support the day-to-day operations of the CRC. Researchers continue to make use of the SAS statistical software available on the CRC computer system. They also use resources available on the Internet.

The computer facility provides hardware and software support for the CRC staff and investigators and statistical assistance to all researchers.

CORE LABORATORY/MASS SPECTROMETRY FACILITY

The Core Laboratory specializes in assays that directly support the research efforts of CRC investigators and are not readily available commercially. The most important and complex assays are undertaken by the Mass Spectrometry Facility, where stable isotope tracer analyses are performed. The Mass Spectrometry Facility is a shared instrument facility that allows CRC investigators to conduct human metabolic studies using stable nuclide tracers. Principal areas of investigation concern the regulation of energy substrate metabolisms in health and disease, and the regulation of whole body amino acid metabolisms, with particular reference to the nutritional requirements for indispensable and conditionally indispensable amino acids. Research at the MIT CRC has made important contributions to the further development of national and international dietary standards and the establishment of sound food and nutrition policies and programs. Studies continue to examine the role of dietary arginine as a precursor of signal transducer nitric oxide. The novel doubly labeled water ($^2H_2{}^{18}O$) method is being used to define the energy requirements for adolescent and elderly subjects, and the factors, which effect these needs. These various investigations offer new basic knowledge about the physiology of a human energy substrate and amino acid metabolism and, additionally, make practical contributions to problems in human nutrition.
The Core Laboratory also utilizes high performance liquid chromatography (HPLC) techniques. A Beckman System Gold Amino Acid Analyzer HPLC provides resolution of up to 42 physiologic amino acids. Other HPLC assays include tests for choline, tryptophan, the catecholamines, cytidine and melatonin.

RESEARCH HIGHLIGHTS

Dr. Linda Bandini and her colleagues have continued to follow-up girls in the longitudinal study of the effect of energy expenditure on growth and development in pre-adolescent girls.

Annually, subjects visit the CRC for measures of height, weight, and anthropometric measures. In addition they complete questionnaires regarding their activity and dietary patterns. Girls complete the study four years after menarche. At study completion the girls body composition and metabolic rates are measured in addition to their annual measures. As of November 30,1999, 107 girls had completed the longitudinal study and 52 remained active in the study. In a subcohort of 40 girls, abdominal scans were done at menarche to measure visceral fat. In these girls, visceral fat is again measured at study completion.

Because this is a longitudinal study, the results of the study will not be available until study completion. This study will allow the investigators to determine whether reductions in daily energy expenditure or any component of energy expenditure is a risk factor for the development of obesity in adolescent girls.

Dr. Bandini is also investigating the relationship of visceral fat to diet, activity, and hormonal changes in a subcohort of girls. These studies will provide information on variable that may influence visceral fat deposition. Determining what factors influence the deposition of visceral fat will provide useful information for the prevention of diabetes and heart disease.

Dr. Steven Grinspoon and his colleagues conducted studies to determine the effects of rh IGF-I (a nutritional-dependent anabolic hormone with potent effects on bone formation) and of estrogen on bone density in women with anorexia nervosa.

Fifty-percent reduced bone density is a common manifestation of anorexia nervosa (AN). More than 50% women with AN will have significant bone loss. Bone loss in AN occurs at a young age, and is often resistant to improvement with existing therapies such as estrogen. Bone formation is significantly reduced in women with AN, in association with increased bone resorption. To address the issue of low bone formation in anorexia nervosa, Dr. Grinspoon designed a double-blind randomized, placebo controlled, trial of rh IGF-I. Short-term studies have shown a significant increase in bone formation in response to rh IGF-I. Recruitment for this study is ongoing and the data investigating specific predictive factors for regional bone loss in AN have recently been submitted for publication. Studies have shown that nutritional factors, more than indices of estrogen deficiency or other estrogen-related parameters, determine regional bone loss in a cohort of more than 130 patients with AN that have been screened.

Dr. Richard Wurtman and his colleagues examined the effects of giving a single dose of phentermine (15 or 30 mg, N=17), or daily doses (30 mg) for five days (N=8), on levels of dopamine and serotonin in platelet-rich plasma, examined at various time points (0-4 hr) after drug administration.

They found that phentermine caused significant elevations in platelet serotonin without increasing those of plasma serotonin. Inasmuch as platelets are unable to synthesize this amine, its increase must have reflected diminished metabolism - by the enzyme monoamine oxidase (MAO). This confirmed older in vitro data showing that phentermine is an MAO inhibitor.

The demonstration that, in humans, phentermine is an MAO inhibitor probably explains why some individuals who took "fen/phen" (fenfluramine - a serotonin releaser and uptake blocker - and phentermine) developed cardiac valvular lesions. The fenfluramine blocked the ability of platelets to take up plasma serotonin, and the MAO inhibition by phentermine blocked the only other pathway available for getting rid of the plasma serotonin, i.e., enzymatic degradation in liver, kidney, etc. The transient, but repeated, elevations in plasma serotonin levels that followed probably caused damage to the heart valves, and such damage probably would not have occurred (nor has it been seen) in patients just taking fenfluramine or phentermine alone. Unfortunately, phentermine activity as an MAO inhibitor still is not mentioned on its label.

Professor Vernon R. Young gave the 5th Annual Fisher Lecture at Rutgers University and the keynote address at the 8th Asian Congress of Nutrition.

Dr. Young and his colleagues have continued to explore quantitative aspects of amino acid metabolisms in healthy adult humans, with particular reference to their nutritional corollaries. Studies have been completed to the effects of a sulfur amino acid-free diet on whole blood glutathione (GSH) synthesis, showing that GSH production is regulated by the dietary availability of one of its precursors, cysteine. Studies have also been completed on the kinetics and urinary excretion of L-5-oxyoproline, an intermediate of the gamma-glutamyl cycle of GSH synthesis. Both sulfur amino acid-free and glycine-free diets alter the dynamics of oxyoproline metabolism and increase the urinary excretion of this intermediate which may, therefore, serve as a potential probe of the status of GSH metabolism of GSH metabolism in human subjects. Studies have also continued on the kinetic aspects of amino acid metabolisms in particular adults. Studies with lysine and threonine as the test amino acids again confirm the hypothesis that the current international requirement values for the indispensable (essential) amino acids in healthy adults are far too low and support that the tentative MIT amino acid requirement pattern is an appropriate one for use in practical considerations of adult human protein and amino acid nutrition. These findings and conclusions have major significance with respect to the planning of diets and an evaluation of diets for their amino acid adequacy worldwide. They also have important implications with respect to the planning of agricultural research programs that are directed toward improving the nutritional quality of foods in humans.

More information about this department can be found on the World Wide Web at http://web.mit.edu/crc/www/.

DIVISION OF COMPARATIVE MEDICINE

The Division of Comparative Medicine (DCM) provides animal husbandry and clinical care for all research animals on the MIT campus. From its inception in 1974, the Division has evolved into a comprehensive laboratory animal program that provides a full range of veterinary and surgical support. Additionally, the Division has a National Institutes of Health (NIH) grant for training veterinarians for careers in biomedical research. Total personnel in the Division now comprises 105 individuals. In March 1998 the Division moved its administrative, diagnostic and research laboratories to the newly renovated eighth floor of Building 16. This space is contiguous to the eighth floor of the newly renovated Building 56, which also houses quarantine, diagnostic and research space for DCM.

The Division's state-of-the-art rodent facilities are either new or have been renovated during the past five years. The average daily census of laboratory animals grew approximately 9 percent during FY00. Mice remain the primary species used by MIT investigators and represent more than 97 percent of the animal population. The animal facilities support transgenic and gene "knockout" *in vivo* experiments. DCM now performs *in vivo* embryo transfer for rederivation of mice with endemic disease which have been imported to MIT from laboratories worldwide. The Division has begun to develop expertise in aquaculture and now provides veterinary support to the Sea Grant Program and Woods Hole Biomedical Institute.

Current NIH-funded grants support *in vivo* study of nitrite carcinogenesis, *in vivo* study of *Helicobacter hepaticus* and tumorigenesis, *in vivo* study of the pathogenesis of inflammatory bowel disease, *in vivo* studies of *H. pylori* pathogenesis and the role of *Helicobacter felis* and *H. mustelae* in inducing gastric cancer. A private pharmaceutical firm has provided funding for studies focusing on *H. pylori* pathogenesis. FY00 was the twelfth year of the Division's NIH postdoctoral training grant that has been funded through year 15. There are currently six postdoctoral trainees, two of whom are enrolled in the graduate programs in the Division of Bioengineering and Environmental Health. Twenty-two trainees have completed our postdoctoral training program and 21 of them have now passed the board examination of the American College of Laboratory Animal Medicine.

DCM faculty and staff published five chapters, 15 papers and 35 abstracts in FY00 and presented numerous research papers at national and international meetings.

Dr. Barbara Sheppard joined the joined the Division as a Comparative Pathologist. Recruitment is underway for an additional pathologist and a clinical veterinarian. Dr. James Fox received the Foundation Award for Excellence in

Research from the American Veterinary Medical Association. He also received the Nathan R. Brewer Scientific Achievement Award from the American Association of Laboratory Animal Medicine for identifying, naming and describing diseases associated with *Helicobacter* species. Dr. David Schauer earned tenure as an Associate Professor in the Division of Bioengineering and Environmental Health. DCM faculty and staff taught graduate courses Toxicology 201 and 214.

The web site for the Committee on Animal Care provides required forms, continuing education material, information on the CAC's activities and schedules for training sessions. DCM staff in conjunction with the Committee on Animal Care once again conducted didactic training sessions for Institute personnel on topics pertaining to the care and use of laboratory animals. The CAC has also increased efforts in screening animal users for occupational health issues. The CAC continued to distribute to other institutions in the United States and abroad two instructional videos, one focusing on the role and responsibilities of Institutional Committees for the Care and Use of Animals and the other focusing on the use of anesthesia in laboratory animals. Both are available to MIT researchers at the Division or in the Schering-Plough Library.

James G. Fox

HARVARD-MIT DIVISION OF HEALTH SCIENCES AND TECHNOLOGY

The Harvard-MIT Division of Health Sciences and Technology (HST) brings engineering, science, technology and medicine to the solution of problems in biology and human health. A successful 30-year collaboration of the Massachusetts Institute of Technology (MIT), Harvard University, Harvard Medical School (HMS), area teaching hospitals, and research centers, HST has been a pioneer in interdisciplinary educational and research programs designed to educate outstanding minds, cultivate leaders, create knowledge, and generate cost-effective preventive, diagnostic and therapeutic innovations. It is among the largest biomedical engineering and physician-scientist training programs in the United States.

Advances in biology and technology are bringing us to an era where disease can be treated by "engineering" the phenotype of cells and tissues—where cell, tissue, and body functions can be manipulated using strategies affecting genes, cells, and their environment so that they behave in predictable ways. Inexorably linked to these fundamental changes in the approach to disease management are advances in our ability to diagnose and prevent disease. There is no question that success demands individuals with a broad range of skills spanning the domains of science, engineering and medicine.

HST is dedicated to integrating these disciplines into an educational program that carries engineering and the physical and biological sciences from the laboratory bench to the bedside, and clinical insight from the bedside to the bench. Our programs are committed to exploring the fundamental principles underlying diseases, seeking new pharmaceuticals and devices to ameliorate human suffering, and training the next generation of physicians, scientists, and engineers to do the same. Thus HST trains physicians to have a deep understanding of the underlying quantitative and molecular science of medicine and biomedical research. HST Ph.D. students similarly are trained to have a deep understanding of engineering, physical sciences and the biological sciences, complemented with hands-on experience in the clinic or in industry.

HST Degree Programs

Today HST is composed of 320 students who work with more than 200 faculty and affiliated faculty members drawn from throughout the Harvard and MIT communities. HST offers six multidisciplinary graduate degree options, each targeted at students with different backgrounds and goals, each requiring a focused educational and research program, and each offering a different level of clinical training.

- The Medical Sciences (M.D.) Program
- The Medical Engineering and Medical Physics (MEMP) Program
- The Speech and Hearing Sciences Doctoral Program
- The Radiological Sciences Joint Program
- The Medical Informatics Program

The Clinical Investigator Training Program..

HST Research Programs

The research programs for students and faculty similarly reflect the mixing of cultures in applying the appropriate tools of medicine, engineering, and science to address problems in human health and clinical medicine. HST Research initiatives fall into four major interdisciplinary areas and presently two major disease-focused areas:

- Functional and Structural Biomedical Imaging
- Functional Biotechnologies
- Biocomplexity

- Biomedical and Health Information Technologies
- Speech and Hearing Sciences
- Cardio-Pulmonology

Through these programs, HST seeks to explore the fundamental principles underlying disease, discover new pharmaceuticals and devices to ameliorate human suffering, and train the next generation of physicians, scientists, and engineers to do the same.

Because of its interdisciplinary and inter-institutional nature, HST's administrative home is the Whitaker College of Health Sciences and Technology at MIT. However, a manager and an administrative assistant are located at Harvard Medical School. The Division's two directors, Martha L. Gray for MIT and Joseph Bonventre for Harvard, report to Robert A. Brown, Provost at MIT; J. David Litster, Vice President for Research at MIT; Dennis Kasper, Executive Dean for Academic Programs at HMS; and Joseph Martin, Dean of Harvard Medical School at HMS. Richard Mitchell, Assistant Professor of Pathology at Harvard Medical School, serves as Associate Director of HST and Director of Student Affairs for HST-M.D. students. Frederick Schoen, Professor of Pathology at HMS, serves as HST Associate Director for Academic Programs..

HIGHLIGHTS OF THE YEAR

Thanks to a $20 million gift in 1999, HST will establish the Athinoula A. Martinos Center for Functional and Structural Biomedical Imaging. The Martinos Center will be a state-of-the-art imaging center established specifically to bring together the extraordinary strengths in science, engineering and technology found at MIT, coupled with the equally powerful strengths of the medical and clinical sciences found at Harvard Medical School and its affiliated hospitals. Under one roof, HST will bring together engineering and the physical sciences, computational sciences and informatics, basic and applied biological sciences, imaging and radiological sciences and clinical sciences. The mission of the Martinos Center is to design and build the next generation of functional imaging tools and to apply these tools to biologically and clinically relevant problems; to provide training for physical, biological and clinical scientists and to serve as a hub for interdisciplinary collaborations across Harvard and MIT. The Martinos Center will house low and high-field MRI for human and animal imaging, magneto-encephalography (MEG), optical imaging, and PET. The initial areas of focus will include: systems-level imaging, high-field human MRI, high spatial and temporal functional mapping of the brain and heart, optical imaging and pharmacological imaging.

Kenneth I. Shine, M.D. gave the keynote address at HST's Commencement Exercises in June, 2000. Dr. Shine is the President of the Institute of Medicine of the National Academy of Science, and Professor of Medicine Emeritus, UCLA School of Medicine, where he is also past Dean and Provost for Medical Sciences.

The 13th annual HST Forum, entitled "The Speech Chain", was held on March 9, 2000. Forty-seven students presented their work at the afternoon poster session, and three faculty spoke at the plenary session. Dr. Kenneth Stevens, Clarence J. Lebel Professor of Electrical Engineering at M.I.T. presented a seminar entitled "Toward Models for Human and Machine Recognition of Speech". Dr. Donald K .Eddington, Associate Professor of Otology and Laryngology at Harvard Medical School and Principal Research Scientist at M.I.T. spoke on "The Cochlear Implant: A Neural Prosthesis for the Deaf". Dr. Jennifer Melcher, Assistant Professor of Otology and Laryngology at Harvard Medical School and the Massachusetts Eye and Ear Institute delivered a presentation entitled "Imaging the Human Central Auditory system: Function and Dysfunction." The evening was capped by a reception and dinner at the Cambridge Marriott Hotel.

For almost 10 years, the Boston Heart Foundation (BHF), located in Kendall Square, Cambridge, has been a clinical research affiliate of the Harvard/MIT division of Health Sciences and Technology (HST). The BHF was founded by Dr. Robert S. Lees, an HST professor with more than 30 years of service to MIT. This past spring, the Co-Directors of the HST Program, Drs. Joseph Bonventre and Martha Gray, invited the BHF to become the HST Cardiovascular Genomics Center. The BHF has a large and loyal multi-generational outpatient population which includes families with the more common precursors of heart disease such as familial hypercholesterolemia, and also rarer ones such as the hypoalphalipoproteinemias and sitosterolemia. The BHF medical staff provide inpatient care, when needed, at the Massachusetts General Hospital. The BHF has an international reputation for providing outstanding, personalized medical care for both common and rare diseases of the heart and blood vessels. Its research programs in the causes, diagnosis, and treatment of heart disease, which involve MIT undergraduate and graduate students, as well as HST medical and medical engineering students, are equally well recognized. In a world in which genomics—the study of the role of genes in the cause and treatment of disease—is becoming central to medical science, the formal affiliation of the BHF and HST promises to bring better understanding of the causes, treatment, and prevention of heart disease. It will continue to provide exciting research opportunities to our students and increased benefits to patients. At its May 2000 meeting, the formal affiliation between HST and the BHF was

proposed by HST Co-Director Joseph V. Bonventre to the BHF Board of Directors. The latter approved unanimously.

OUTSTANDING STUDENTS

Thirteen students graduated with Ph.D. degrees; thirty-five students received the M.D. degree, nine students received M.D. and Ph.D. degrees, and two students received the M.S. degree. Special recognition also went to five students who graduated cum laude and five who were recognized with magna cum laude.

The following HST students received awards at the June 2000 Commencement ceremonies:
Amy E. Adams, M.D., Ph.D. received the Kurt Isselbacher Prize (Harvard Medical School) for the student demonstrating humanitarian values and dedication to science.
Howard Y. Chang, M.D., Ph.D. received the Leon Reznick Memorial Prize (Harvard Medical School) for excellence and accomplishment in research.
Anthony Chen, M.D. received the Multiculturalism Award (Harvard Medical School), awarded to the student who has done the most to exemplify and/or promote the spirit and practice of multiculturalism and diversity.
Rose Du, M.D., Ph.D. (Physics, MIT), received the James Tolbert Shipley Prize (Harvard Medical School) for Excellence and Accomplishment in Research.
Whitney B. Edmister, M.D., Ph.D. (Medical Engineering/Medical Physics, MIT) received the Dr. Sirgay Sanger Award for excellence and accomplishment in research, clinical investigation or scholarship in psychiatry.
Marcus Ware, M.D., Ph.D. received the Harold Lamport Biomedical Research Prize (Harvard Medical School) for the best paper reporting original research in the biomedical sciences.
Shunmugavelu D. Sokka received the Student Leadership award in the HST Medical Engineering and Medical Physics Program.

FACULTY HONORS AND AWARDS

Dr. Martha Gray, HST co-director, was appointed Edward Hood Taplin Professor of Medical Engineering and Electrical Engineering. Dr. Elazer Edelman, Thomas Cabot Associate Professor of HST, received the inagural Thomas A. McMahon award for mentoring in the Harvard-MIT Division of Health Sciences and Technology. Dr. Lee Gehrke, L.J. Henderson Professor of HST received the mentoring award from the Program in Biological and Biomedical Sciences at Harvard Medical School. Dr. Richard H. Masland and Dr. David N. Louis received the 2000 Irving M. London Teaching awards presented by the Harvard-MIT Division of Health Sciences and Technology.

RESEARCH ACHIEVEMENTS

The research of the HST core faculty and research staff covers a wide spectrum of biomedical areas. In addition to labs at HST, MIT and Harvard, research links include a number of Harvard Medical School teaching hospitals (MGH, BWH, BIH, NEDH) and the Harvard Medical School quadrangle.

Biomedical Engineering/Biological Physics

Richard J. Cohen (HST '76) received permission from the US Food and Drug Administration on April 13, 1999, to market a test that can accurately predict the risk of heart arrhythmia. Professor Cohen, who studies the mechanical regulation and stability of the cardiovascular system, invented the T-Wave Alternans Test. One in seven Americans will eventually die of sudden cardiac death. Effective preventative treatment is available in the form of the implantable cardioverter defibrillator, but until recently it has not been possible to identify in advance the patients that require this therapy. This test, which is the only test that the FDA has approved for this indication, involves the analysis of microvolt level fluctuations in the electrocardiogram during exercise stress.

Elazer R. Edelman (HST '83) uses elements of continuum mechanics, digital signal processing, and polymeric controlled release technology to examine the cellular and molecular mechanisms that transform stable coronary-artery disease to unstable coronary syndromes. Tissue-engineered cells, for example, deliver growth factors and growth inhibitors for the study and potential treatment of accelerated arterial disease following angioplasty and bypass surgery. Professor Edelman is motivated by a tough clinical problem: more than half of blocked blood vessels that are cleared by a procedure called balloon angioplasty become blocked again. His discoveries have lead to patents for endovascular stents, drug-delivery devices, tissue-engineered implants, and new drug formulations.

Frederick J. Schoen has made major investigative contributions to understanding the problems of currently available prosthetic devices and patient management strategies. He has identified, elucidated the mechanisms of, and solved several of the critical problems associated with the biomaterials and devices used clinically. His approaches have used basic biology, evaluations of clinical implants that have failed, and industrial development studies of new and modified configurations and biomaterials.

Michael S. Feld heads the MIT Laser Biomedical Research Center, an NIH Biotechnology Resource Center housed in the MIT Spectroscopy Laboratory, which develops basic scientific understanding, new techniques, and technology for advanced biomedical applications of lasers. One area of research is the spectral diagnosis of disease using fluorescence, reflectance and Ramaan scattering. The techniques are implemented clinically by means of optical fiber catheters and imaging endoscopes. One example of progress over the past year is HST Ph.D. student Jason Motz's development of techniques for analyzing Ramaan scattered light from atherosclerotic plaques to extract information about the relative amounts of the morphological constituents present, such as necrotic core, smooth muscle cells, and calcification. Probes for collecting Ramaan spectra during clinical procedures are being developed.

Laurence Young continues actively as Director of the National Space Biomedical Research Institute (NSBRI), the primary agency for NASA-sponsored space biomedical research. Since its founding in June 1997, the Institute has nearly doubled in size, expanding the number of consortium members from 7 to 12, and the number of research teams from 8 to 12. In his role as NSBRI investigator, Professor Young directs two research projects. His NSBRI ground-based study of Principal Investigator-in-a-Box (also known as [PI]) tests the effectiveness of [PI] as an expert system designed to assist astronauts in the monitoring and troubleshooting of experiments conducted during space flight. His NASA Ames-sponsored [PI] project flew on the space shuttle twice during 1998: on Neurolab and with John Glenn on STS-95. Prof. Young is also leading a major new research initiative in artificial gravity. Results from these efforts will help define the limitations and benefits of various possible countermeasures to the postural instability and disorientation problems that result upon a return to gravity after long-duration space flight. He is collaborating on other research being prepared for the International Space Station, including the MICRO-G project to provide advanced force and moment sensors, and a virtual reality experiment informed by Neurolab experience (Profs. L.Young and D. Newman, Dr. C. Oman). Profs. Dava Neuman and Young have also worked with NSBRI and HST toward developing a new graduate program in Space Life Sciences.

Lisa E. Freed, Principal Research Scientist in HST, supervises a research team working on tissue engineering. Her research interests include cell and developmental biology, biomaterials, and biomedical engineering, and in particular the integrated use of cells, 3-dimensional scaffolds, and bioreactors to engineer functional skeletal and cardiovascular tissues. The goals are to improve our basic understanding of tissue development through controlled in vitro studies and to generate clinically useful tissue equivalents.

Gordana Vunjak-Novakovic, Principal Research Scientist in HST and Adjunct Professor of Chemical Engineering at Tufts University, is supervising research teams working on engineered skeletal and cardiovascular tissues and biological research in microgravity. Her research interests include transport phenomena, tissue engineering and bioreactors, and in particular the integrated use of cells, biomaterials and bioreactors to model biological and engineering aspects of tissue development. She leads the science design and testing of the cell culture system for the International Space Station. Imaging Sciences and Technology

Imaging Sciences

Emery N. Brown devotes his research to statistical modeling of problems in neuroscience. Working jointly with colleagues in the Brain and Cognitive Sciences Department at MIT, he has been developing statistical signal processing techniques to analyze how neural systems encode information about relevant biological stimuli in their ensemble firing patterns. The techniques involve signal processing methods based on point process filtering and have been successfully applied to the study of how ensembles of pyramidal cells in the rat hippocampus encode the animal's representation of its spatial environment. In collaboration with members of the MGH NMR Center, Professor Brown has been developing statistical methods to characterize the dynamic properties of functional magnetic resonance imaging (fMRI) signals. A forthcoming application of these methods will be to study anesthesia-induced loss of consciousness monitored with fMRI. In collaboration with colleagues at the Brigham and Women's Hospital, Professor Brown has developed a statistical model to measure precisely the period of the human biological clock.

Martha L. Gray (HST '86), Director of HST, and collaborator Deborah Burstein (HST '86) use magnetic resonance for measuring composition and functional integrity of cartilage. Over the last century, clinicians and researchers have had to struggle to understand and treat diseases they couldn't see until significant cartilage destruction had occurred. This situation has the potential to improve dramatically with the method Professors Gray and Burstein have pioneered. In the past year this method has been used to nondestructively demonstrate biochemical alterations in intact human cartilage. In addition, pilot clinical studies have begun to demonstrate subtle alterations in cartilage, which may be amenable to early pharmacologic intervention

Bruce Rosen (HST '84) is the Director of the NMR Center at the Massachusetts General Hospital. He is well known for his contributions in the area of "functional" imaging–that is, magnetic resonance images of the brain in

which areas having some functional activity (e.g., visual cortex) are highlighted by receiving increased blood flow. The techniques he and his colleagues have developed are now being used by hospitals throughout the world in evaluating patients with stroke, brain tumors, dementia, and other mental illness. Recent work has focused on the fusion of functional MRI data with information from other modalities, including very high temporal resolution signal using magnetoencephalograpy (MEG) and non-invasive optical imaging.

Robert Lees and his colleagues have devised a noninvasive method for assessing atherosclerosis in the abdominal aorta, the site where the disease begins and is sometimes found even in children. They are using magnetic resonance imaging, with quantitative analysis, of the images. They plan to use this technique–along with the established method of quantitative carotid ultrasound–to determine the effects on the progression (or regression) of atherosclerosis with interventions such as the new cholesterol-lowering margarines (whose action may be slower, but more tolerable than that of cholesterol-lowering drugs). The new technique is one of a number of methods they have developed and brought into the clinic during their thirty years of cardiovascular imaging and diagnostic research at MIT.

Experimental Diagnostics/Therapeutics

One of the most visible and obvious arenas in which the bench-to-bedside transfer is a two-way bridge is with regard to therapeutics. Drugs and therapies not only may treat disease by serving as probes, but they can provide important insights into disease mechanisms and offer diagnostic opportunities. Most faculty in HST are involved at some point in clinical human studies. The support of a clinical research center at MIT and the teaching hospitals, and the recently launched Clinical Investigator Training program, have significantly enhanced the infrastructure, further enabling translational efforts.

Martin Yarmush and colleagues are making contributions to several fields, including tissue engineering, gene therapy and nucleic acid biotechnology, and metabolic engineering. Professors Yarmush, Mehmet Toner, and Ronald Tompkins are collaborating on one of the world's leading programs to establish a liver support device using hepatocytes and microfabrication techniques. Also in the area of tissue engineering, Professors Jeff Morgan and Yarmush are developing the next generation of skin substitutes using genetically modified cells. In the areas of gene therapy and nucleic acid biotechnology Professor Yarmush's lab, together with those of Professors Morgan and Charles Roth, are investigating rate limiting aspects of gene therapy and antisense therapy. Finally, Professors Yarmush and François Berthiaume are using the tools of metabolic engineering to investigate the complex metabolic changes that occur in chronic disease and major injury.

Richard J. Wurtman, M.D., program director of MIT's Clinical Research Center, also does research in Alzheimer's Disease. A generally held–if unproved–view of Alzheimer's is that dementia results from toxic effects of an abnormal protein, called amyloid, which is a polymer of small fragment (A-beta) of a protein (APP) that is produced normally in all cells. Hence, a major goal of researchers hoping to treat this disease is to find drugs that will decrease the formation of A-beta from APP, and increase the production of APP's other major metabolite APPs ("soluble APP"). Wurtman's laboratory has now shown that both the synthesis of the APP and the proportions of it that are broken down to A-beta or soluble APP are under the control of particular neurotransmitters and "second messengers" they generate. Thus, using drugs that act on these receptors, it should be possible to block the formation of APP and all its metabolites, or promote the formation of soluble APP and suppress A-beta. This has now been demonstrated in tissue culture and is in the process of being demonstrated in animal models of Alzheimer's. The next step, probably involving industry collaboration, involves devising a treatment to decrease the amount of amyloid in the Alzheimer's Disease brain. This treatment may conceivably ameliorate the dementia of the disease.

Robert H. Rubin has spent much of his clinical career studying and caring for transplant patients. Among his accomplishments are the development of new strategies for preventing the most important infections, particularly those due to viruses and fungi; the establishment of the link between certain viral infections and allograft injury and the development of certain malignancies; and the development of novel antimicrobial approaches that are effective not only in transplant patients but also in such other immunocompromised patient populations as those with AIDS and cancer. In 1999, he was named to the chairmanship of the Infectious Disease Section of the International Transplantation Society. As director of the HST Center for Experimental Pharmacology and Therapeutics, Dr. Rubin has pioneered in the application of positron emission tomography, magnetic resonance imaging and spectroscopy, and other measurement technologies to the development of new drugs, including those designed for the transplant patient. Professors Rubin and Alan C. Moses head a two-year Clinical Investigator Training Program, a joint effort of the Beth Israel Deaconess Hospital, HST and Pfizer, Inc. Trainees gain direct experience in clinical investigation and a strong foundation in the statistical and computational sciences, biomedical ethics, principles of clinical pharmacology, in vitro and in vivo measurement techniques, and aspects of the drug development process. After fulfillment of thesis requirements and successful performance on a qualifying exam, graduating trainees receive a M.M.Sc. degree in Clinical Investigation from HST.

Daniel Shannon is a founder of the field of pediatric intensive care and pulmonology. For more than two decades, he has been furthering his breakthrough studies into the rare condition of congenital central hypoventilation syndrome (CCHS). Professor Shannon and his colleagues have added incrementally to their framework of knowledge about the problem, using whatever new tool they could find to test specific hypotheses. One of his associates in these studies recently received an award from the NIH for discovering the first gene that controls respiration. Still, the clinical problems–like a child's failure to breathe adequately when asleep–continue to stump clinicians and researchers alike. His latest research reflects the use of technology to better serve patients.

Robert S. Langer, Jr., a pioneer in biomedical and chemical engineering, is studying new ways to deliver drugs, including a new microchip that can deliver drugs in a pulsable fashion. He is also researching tissue engineering and has created new approaches for creating blood vessels, cartilage, and many other tissues. He has also developed biomaterials for medicine, including plastic that slowly dissolves and releases therapeutic drugs directly to tumors. In 1996, this led to the first new treatment for brain cancer approved by the FDA in more than twenty years.

Roger G. Mark, together with colleagues at HMS, Boston University, and McGill University launched the new NIH-funded Research Resource for Complex Physiologic Signals. The Resource investigates cutting-edge physiologic signal processing techniques, and freely distributes extensive archives of annotated physiologic data and signal processing software to the international research community via the internet (www.physionet.org). Professor Mark's group also is developing computational cardiovascular models to better understand orthostatic intolerance induced by space flight, and is exploring innovative approaches to 'intelligent' patient monitoring.

Dr. Chi-Sang Poon, Principal Research Scientist, reported that newborn mice lacking the gene for a key subunit of the NMDA receptor developed abnormal depression of neurotransmission in a brain region important for vital physiological functions and subsequently died of respiratory failure prematurely within the first day of life. This finding raised concerns about the exposure of pregnant women to certain common anesthetic and illicit drugs, and such caution received attention in major biomedical publications including the British medical journal Lancet. A graduate student in Dr. Poon's lab, Daniel L. Young, received an individual predoctoral fellowship award from the National Institute of Mental Health for his proposed thesis research in neuroengineering. This was the only award of this kind that had been won by a MIT graduate student in recent years.

Stephen Burns is interested in medical instruments in the developing world. He and his students are using inexpensive personal computer technology to implement devices characterized by intensive signal processing. They have developed an electrocardiogram machine and are currently working on several ophthalmic instruments for screening for glaucoma including a through-the-eyelid tonometer.

James C. Weaver, Senior Research Scientist, and colleagues at MIT and Chicago are carrying fundamental theoretical studies of the conditions under which weak electric and magnetic fields (EMF) can alter biochemical processes. Their recent paper in Nature shows that biological sensing based on magnetically sensitive chemical reactions should be possible, and could allow detection of remarkably small magnetic field difference.

Medical Sciences and Molecular Medicine

Jane-Jane Chen, Principal Research Scientist in HST, studies the regulation of hemoglobin synthesis and erythropoiesis by the heme-regulated eIF-2 alpha kinase (HRI) that is responsible for the translational regulation by heme of globin synthesis. Her group has knockout the HRI gene in mice. In iron-deficiency, HRI null mice maintain the nomal cell size and hemoglobin content of the red blood cells, in contrast to the hypochromic and microcytic red blood cells of wild type mice. In addition, there is a structural alteration in the red cells and a decrease in toatl red blood cell number in the HRI null mice under these conditions. Thus, HRI is required for the well being of the mice in iron deficiency. These data have significance for further understanding the physiological role of HRI in the production of not only hemoglobin, but also red cells

Lee Gehrke studies the replication and assembly of viruses that use RNA as their genetic material. Key biochemical processes that allow viruses to replicate depend on docking interactions between RNA and protein molecules. Professor Gehrke's laboratory is focused on identifying these docking signals, an effort that will facilitate therapeutic approaches for blocking virus replication and assembly. The research has led to the molecular identification of amino acids and nucleotide sequences that are crucial for forming the RNA-protein interactions; moreover, the work also suggests the shape or conformation of the molecules changes upon binding. Another aspect of his work is learning how viruses are able to gain an advantage over the infected host cell in expressing their own genetic information. Nucleotide signals in a viral messenger RNA have been identified that give the virus a competitive advantage, and the lab is now working to elucidate the detailed mechanism.

Irving M. London, Founding Director of HST and Professor of Biology, Emeritus, is studying the regulation of hemoglobin synthesis at both transcriptional and translational levels. His laboratory has discovered and characterized the main enhancer elements that control the transcription of the human ß-globin. In collaboration with Professor Philippe Leboulch of the Harvard Medical School faculty, Dr. London is also focusing on novel gene transfer strategies for the gene therapy of human diseases, especially sickle cell anemia and thalassemia.

George Q. Daley (HST '91) is investigating the signaling pathways that allow the BCR/ABL oncoprotein to induce leukemia. His laboratory has demonstrated that a novel class of pharmaceutical agents called farnesyl transferase inhibitors have potent activity against BCR/ABL-induced leukemia, and plans are underway for clinical trials in humans. His lab has also demonstrated that hematopoietic stem cells develop from totipotent embryonic stem (ES) cells that are differentiated in culture, an important step towards using ES cells for cellular therapies.

Richard Mitchell researches the mechanisms underlying acute and chronic rejection in solid organ allografts, with specific emphasis on heart transplants. The work runs the gamut from mouse transplant models to human clinical transplantation, and is focused on understanding the specific immunologic pathways that drive rejection and ultimately graft failure. His lab is particularly interested in the mechanisms that induce the process of "chronic rejection" whereby the vessels in transplanted hearts become progressively more occluded until the grafts get starved for blood and die. The research may have much broader applicability, since the inflammatory mediators that drive the occlusive process in transplanted hearts may also be involved in mediating the vascular wall thickening that characterizes more "typical" atherosclerosis. Professor Mitchell's lab uses a number of genetically-engineered mice (so-called "knock-out" mice) that are either deficient in cell surface molecules that promote the cellular cross-talk necessary to promote rejection, or that lack particular "cytokine" mediators or their receptors. In collaboration with other members of the HST community, such as Elazer Edelman and Andrew Lichtman, Professor Mitchell has been evaluating new interventions to prevent the chronic vascular pathology. His group has also developed collaborations with a number of pharmaceutical firms such as Schering-Plough, Bristol Myers-Squibb, and Novartis

Joseph V. Bonventre (HST '76), co-director. studies the mechanisms of cellular and tissue injury and repair, particularly as related to ischemic injury to the kidney. Recent studies have focused on the role of inflammation and adhesion in the pathophysiology of acute renal failure. A novel adhesion molecule has been cloned that is expressed at very high levels during the recovery phase of acute renal failure and in models of chronic renal disease as well as in a number of human kidney diseases including polycystic kidney disease. Using PCR based subtraction techniques and bioinformatics a large number of additional genes whose regulation is altered during repair have been identified. Many of these represent potential targets for therapeutic interventions to prevent or treat kidney injury. Transcription factors are important determinants of the cellular repair processes after an ischemic insult to the kidney. A novel kidney-specific zinc finger transcriptional repressor, Kid-1, whose expression is regulated in renal ontogeny and by ischemia/ reperfusion was cloned and characterized. The Kruppel Associated Box-A (KRAB-A) motif of this and other zinc finger proteins was identified as a common repressor motif. A transcriptional repressor, KRIP-1, that interacts with KRAB-A has been cloned. A new family of proteins that associate with KRIP-1 (Trip-Br family) have been characterized which interact with E2F/DP1, two critical proteins for cell cycle regulation. A second major focus of the lab is phospholipase A2 (PLA2) and the role of this family of enzymes on acute tissue injury, apoptosis, signal transduction and nuclear events including transcription. Using the yeast two- hybrid system a nuclear protein that interacts with the cytosolic 85 kDa cPLA2 has been identified. A cPLA2 knock-out mouse has been created to study the function of PLA2s in signal transduction and renal, respiratory, gastrointestinal and neurological disease. Gene therapy approaches with adenovirus are being used.

Bioinformatics and Medical Informatics

Knowledge discovery and its dissemination in health care have been deeply influenced by recent advances in computer science and engineering. Medical and Biological Informatics (MBI) is the use of computer technology to extract, transport, and manage information from medical and biological data, and to model and support human decision-making in clinical and biological domains. The field is a scientific and engineering activity which is inherently multidisciplinary. Research challenges include: deducing and mapping genomic structure, predicting structure and function of proteins, representing medical knowledge for modeling diagnostic and prognostic decision-making processes, extracting new information from large clinical and biological datasets, building comprehensive electronic medical records (EMR) and clinical information systems, interfacing monitoring devices and the EMR, assuring privacy and confidentiality in medical transactions, analyzing and manipulating images, recognizing patterns of disease progression, analyzing costs and benefits related to medical use of information technology, computer-aided instruction, and utilizing the Internet for providing education and health care services.

Robert Greenes, M.D., Ph.D., Director of the Medical Informatics Training Program, established the Decision Systems Group (DSG) at Brigham and Women's Hospital in 1978 to pursue the application of information technology in physician education and decision making. Professor Greenes has had a 35-year history of work in the

area of medical informatics. The DSG lab, which includes physicians, computer scientists, database experts, graphics and multimedia specialists has its primary focus on developing means to enhance decision support and education in medicine and for integrating these capabilities into clinical practice. For the past ten years, emphasis has been on the development of component-based, distributed, and Internet-based approaches to implementing applications that provide a framework for integration of diverse information resources in a cohesive manner.

Lucila Ohno-Machado investigates machine learning techniques to extract information from clinical databases, especially in the form of predictive models for prognosis. She has used special methods to predict survival for patients with AIDS, to assess the probability of myocardial infarction in certain populations, to predict ambulation for patients with specific kinds of spinal cord injuries, and to predict outcomes in other clinical domains. Her research is focused on the development and evaluation of models involving binary outcomes. She is interested in deploying practical models for direct use by patients, physicians, and health care managers, so that they can make more informed decisions. An example in this area is a project that uses artificial intelligence techniques for dealing with uncertainty to select suitable clinical trials for patients with certain types of breast cancer. Other areas of interest include decision support to help patients recognize early symptoms of a heart attack, patient education, and remote teaching using information technology.

Speech and Hearing Sciences

John J. Rosowski is co-director of the Wallace Middle-Ear Research Unit of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary. He and his colleagues strive to understand how the structures of the external and middle ear affect what we hear through measurements of normal function and structure in normal and pathological ears. On the order of 1% of the human population suffers from some form of chronic middle-ear disease, and thousands of surgeries are performed each year at the Massachusetts Eye and Ear Infirmary alone to control these diseases and restore hearing. The Wallace unit is currently investigating the clinical utility of laser-Doppler measurements of sound-induced middle-ear velocity in patients and human subjects in the diagnosis of middle-ear disease and the evaluation of post-surgical results. Preliminary results indicate certain hard-to-diagnose ossicular abnormalities can be differentiated by vibrometry and that the reasons for a large percentage of middle-ear surgical failures can also be determined by this procedure.

Dennis Freeman has improved imaging of sound-induced motions of sensory cells in the inner ear so that it now possible to reslice the images to view motions from arbitrary perspectives. The ability is similar to tomographic reconstructions done in magnetic resonance imaging (KRI) but at a micrometer scale. Dr. Freeman has also developed novel probes for measuring mechanical properties of the tectorial membrane (a gelatinous structure that plays a key role in mechanically stimulating the sensory cells in the inner ear) based on MEMS (microelectromechanical systems) technology. His laboratory is using the new probes to characterize mechanical coupling of sensory cells through the tectorial membrane.

Charles M. Liberman studies the neurobiology of hearing and hearing loss in animals and humans. His work on normal hearing investigates the structure and function of the four major classes of afferent and efferent neurons connecting the inner ear with the brain. Notable recent progress includes the discoveries that sound-evoked activation of one of the efferent feedback pathways protects the inner ear from permanent acoustic injury and that inter-subject variation in the strength of this feedback reflex can predict susceptibility to hearing damage in noisy environments. His work on hearing loss is currently focusing on prevention of presbycusis, or age-related hearing loss. His laboratory has recently demonstrated a genetic manipulation in mice which dramatically minimizes age-related hearing loss as well as the age-related loss of sensory cells. The molecular mechanisms underlying this protective effect are now under investigation.

Bertrand Delgutte and his colleagues are investigating the neural mechanisms underlying the remarkable ability of normal-hearing people to hear out a sound of interest among competing noises. They recently found a class of neurons in the auditory midbrain that respond better to a sound signal in noise when the signal and the noise originate from different spatial locations. This research may lead to hearing aids and auditory implants that work better in the complex acoustic environments that cause great difficulties to hearing impaired listeners.

FUTURE PLANS

There is tremendous opportunity for growth in HST and for making MIT's contributions to the medical sciences much more substantial and visible.

The Athinoula A. Martinos Center for Functional and Structural Biomedical Imaging provides a paradigm for this growth. It has already enhanced old collaborations and has begun to build new ones, both in the MIT community and the Boston area. It will be temporarily located in the Charlestown research facility of the MGH until it can be permanently located on the MIT campus. This is an exciting collaboration in the Imaging sciences and education

among MIT, Harvard and the MGH and we fully expect that this Center will be the leading education and research venue in biomedical imaging.

A major effort has been placed on rationalizing our faculty appointment process (for affiliated and joint faculty) and increasing the size of the faculty with primary HST appointments.

Additional partnerships have been developed with other departments, schools, Teaching hospitals and industry are important to the growth and health of this Division.

The creation of HST's new Advisory Council has brought new contacts and colleagues in the industrial sector. The goal is to develop new synergies with industry that offer a range of benefits for students, faculty, and professionals working in the private sector.

Our recent partnership with the Harvard Dental School brings new perspectives and disciplines to our curricula. For the first time it will be possible to have Dental students, who are committed to a career as Dental science investigators, enrolled in HST.

HST's charter membership in the National Space Biology Research Institute has brought a considerable amount of money to MIT and has served as a focus for research in manned flight in space. The membership of the NSBRI has been expanded beyond the initial charter group of HST, Johns Hopkins, Baylor, Rice, Moorhouse, and Texas A and M to include the University of Washington, University of Arkansas, Brookhaven labs, University of Pennsylvania, and Mount Sinai Medical School. Additional research programs within the NSBRI have been established with a significant represention of HST faculty within these programs. There is a projected large growth in the funding support for all the NSBRI programs.

The NSF Educational Research Center, which is comprised of faculty from Vanderbilt, Northwestern, U Texas at Austin, and HST, has proven to be an outstanding forum for development of curricula in biomedical engineering. This NSF funded ERC brings together engineers, scientists, and educators including learning scientists in a rich collaboration which approaches the field of biomedical engineering education in a completely novel way.

As medicine and technology continue to change at a rapid pace, so too must curricula. Faculty members at HST to review the entire M.D. curriculum, build the biomedical imaging curriculum and biomaterials educational program, as well as develop a cell and molecular track for MEMP Ph.D. students, to name only a few. We have introduced new course directors in Endocrinology, Renal Pathophysiology, and Biochemistry and have initiated a new course on Creative Writing for physicians that will be taught by Diane Klingenstein of the MIT Writing program.

The Division also continues to work with new technologies to enhance our educational offerings and to offer new opportunities in distance learning and asynchronous networks.

More information about the Harvard-MIT Division of Health Sciences and Technology can be found on the World Wide Web at http://harvard-mit-hst.org/.

Martha L. Gray

CENTER FOR ENVIRONMENTAL INITIATIVES

Established in 1997, The Center for Environmental Initiatives (CEI) supports, coordinates and conducts research and education on environmental and sustainability issues that impact development and welfare worldwide. The work of the center is aimed at providing knowledge, demonstration and collaboration in the development of scientifically and economically sound strategies for industry and government to respond to global environmental challenges. As a neutral broker, CEI aims to foster constructive relationships between industry, governments, academia and the public to seek solutions to environment and sustainability issues. Through interactions in our research and outreach initiatives, CEI also strives to strengthen industry's role as an agent of change for the protection of the environment and sustainability. CEI works to build better understanding of the many issues between and among developed and developing nations that arise in the context of meeting global environmental challenges (including questions of eco-efficiency, equity, futurity and security). A central theme running through all of CEI's initiatives is the role of science and technology in shaping better environmental policy at all levels in both the public and private sectors. The education program of CEI is committed to educating the next generation of environmental and sustainability leaders worldwide via joint projects, distance education and special educational programs.

Professor David H. Marks of Engineering Systems and Civil and Environmental Engineering is Director. Dr. Joanne Kauffman, Principal Research Scientist and Lecturer in Political Science, is Deputy Director. The Executive Committee of the MIT Council on the Environment serves as the Steering Committee for the Center.

MAJOR ACCOMPLISHMENTS

Working with other labs and centers throughout the Institute, CEI has successfully put in place an institutional architecture needed to advance MIT's commitment to greater emphasis on environment and sustainability. Four major programs are in place to facilitate multi-disciplinary research and education initiatives that bring together faculty and students from across the Institute—not just the relatively small percentage who identify themselves as environmental professionals. In 1999–2000, CEI attracted new faculty and additional resources to support multi-disciplinary research programs, expanded its educational initiatives both locally and internationally, launched new collaborations with the World Business Council on Sustainable Development for knowledge exchange between industry and academia, and strengthened its outreach activities and public communications. The research programs of the CEI involve over 50 MIT faculty and over 100 students annually.

With respect to building synergy across the Institute, the CEI provides co-leadership for the Council on the Environment (together with MIT Chancellor Lawrence Bacow), established the Strategic Faculty Workshops for the MIT Consortium on Environmental Challenges, and established a weekly seminar series on global environment and sustainability issues. The seminar series includes presentations of work in progress on environmental challenges as well as timely issues by invited guests.

Two major events of the past year are illustrative of the progress that the CEI has made toward achieving its goals for expanded outreach and communication. First, the CEI acted as the host of the January 2000 Annual Meeting of the Alliance for Global Sustainability. The meeting, which focused on communications and outreach for sustainable development attracted over 350 scholars and representatives from industry, government and NGOs around the world to examine more effective ways for the academic community to translate knowledge to action for sustainable development. The proceedings of the meeting will serve as a resource for our own affiliates as well as other academics who are concerned with the issue of knowledge sharing today. Second, CEI led the development of the new Web site for the Alliance for Global Sustainability, a global resource for information on methodologies and frameworks for decision making that will contribute to solving sustainability issues worldwide.

COMPONENT PROGRAMS

The CEI carries out its mission through four component programs. Three of the programs support and coordinate research for the environment and sustainability. The fourth manages the education initiatives of the center. CEI's four programs in 1999–2000 were: the Alliance for Global Sustainability (AGS, international focus), the MIT Consortium on Environmental Challenges (focus on science and technology in environmental decision making), the Energy Choices Venture Fund (focus on robust technology options for a greenhouse gas constrained world), and the Program on Environmental Education and Research (educational component).

CEI's four major initiatives provide coherence to a strong research portfolio of projects. The projects are not only leading to important results and the development of methodologies for assessment of options for technologies and policies that will support sustainable development in industrialized and developing countries alike, they are also providing tremendous hands-on experience for a growing number of our own students and leading to the development of a world-wide network of leaders in policy and technology who understand the multidimensional aspects of these problems and can identify the resources needed to deal with them.

Alliance for Global Sustainability

AGS-supported research brings together scholars from the three founding partner universities (MIT, the Swiss Federal Institutes of Technology, and the University of Tokyo) with partners from industry, NGOs, government and other leading academic institutions to address complex environmental problems that transcend geographical and disciplinary boundaries. At the annual meeting of the Alliance for Global Sustainability at MIT in January, the AGS Governing Board awarded $1.2 million in funding for 12 new projects over the next two years. This new funding brings the current AGS environmental research commitment to $4.9 million for 41 projects. These projects fall within three major focus areas: water, energy and mobility. In addition, some of the projects address crosscutting issues such as urban systems, cleaner technologies, policies and institutions, and communications and outreach for sustainable development.

AGS project leaders have raised more than $18 million to supplement these projects and related sustainability research at the partner universities.

The January 2000 meeting of the AGS held at MIT marked a turning point for the AGS, as the first tranche of research projects became ready for implementation. Entitled "Agenda for Sustainability: Translating Knowledge into Action and Learning to Lead," the meeting resulted in a significant set of next-step goals for the AGS, including the development of proactive initiatives to impact not only academic discussions, but also development and sustainability actions around the world. As Dr. Jack Gibbons, Senior Fellow of the National Academy of Engineering and former Director of the US Office of Science and Technology Policy noted, "It is not enough simply to do good research—we have an inherent responsibility to translate research results in consideration of society as a whole."

Professor David H. Marks, MIT AGS Coordinator and host of the meeting noted, "While academics are often uncomfortable with the notion of outreach and communication, we also recognize our responsibility to move our knowledge into actions." He pointed to the "tremendous spirit of good will between our faculty, affiliates, students and the many representatives of change agents in governments, foundations, media, and NGOs" who participated in the meeting. The 2001 meeting of the AGS will be held in Lausanne Switzerland where the focus will be on the relationship between science and decision making.

Consortium on Environmental Challenges

Created in 1997, the Consortium on Environmental Challenges (CEC) in 1999–2000 completed Phase I of the research projects it initiated in 1998 with the advice of its Advisory Committee. The CEC examines the role of scientific and technologic knowledge in environmental decision making and seeks to provide recommendations for improving the scientific foundation for policies and decisions that impact the global environment. The MIT Management Team for the CEC includes Professors David Marks, Mario Molina and Kenneth Oye, and Dr. Joanne Kauffman. CEC goals are to:

- Assess global environmental challenges and their impact on ecosystems, economic development and health and contribute to the knowledge needed to meet those challenges.
- Improve policy making through use of unbiased knowledge—scientific, technological, and socio-economic.

CEC scholars from across the Institute are assessing the state of knowledge needed to effectively meet global environmental challenges by focusing on specific issue areas.

Current linkages focus on energy choices for the future; the automobile and sustainability with an emphasis on options for future road transportation; water for a sustainable future, air quality in the world's burgeoning mega-cities (case study on Mexico City), and ways to improve decision-making under conditions of uncertainty. Working papers available from the program include analyses of case studies on the use of science in environmental decision-making, constraints on the use of scientific and technical knowledge in environmental decision-making, and papers on each of the specific project areas.

Through this initiative researchers are looking to understand how to increase the role scientific evidence and technological knowledge play in meeting the challenges posed by environmental risks to economic development and social welfare.

Major accomplishments in the past year of this program include a major conference on credibility of data in environmental decision making, strategic faculty workshops on major issues including genetically modified organisms, and planning for a major workshop on Future Technologies for Road Transportation, led by Professor John Heywood, Dr. Malcolm Weiss, and Dr. Elisabeth Drake. This project is also a component of the Venture Fund for Energy Choices (below). Through the Mexico City Project on Integrated Assessment of Air Quality in the Mega-Cities, Principal Investigators Professor Mario Molina and Dr. Luisa Molina have built a large international team to

develop a method for assessing the causes of and potential solutions for the problem of air pollution at local, regional and global levels that stems from development of the mega-cities. This project, which includes a major education component, has led to major progress in developing a methodology for integrated assessment of complex environmental problems and provided a model for working across disciplinary, cultural, and geographical boundaries.

The MIT Consortium on Environmental Challenges was created in October 1997, when MIT and Ford Motor Company announced a collaboration focusing on education and research. As a component of this partnership, Ford pledged $6 million over five years to initiate and support the Consortium. The program now includes sponsors from Norsk-Hydro, Exxon-Mobil, ABB, and others.

Energy Venture Fund: Energy Choices
A generous gift of $1,350,000 over two years from the V. Kann Rasmussen Foundation allowed MIT to launch broad research initiatives in 1997 focusing on innovative energy solutions. Recently, the Foundation extended its support by $1 million over the next two years. These funds are used in conjunction with funds raised from corporate and other sponsors to pursue important research in strategic areas of opportunity.

The Steering Committee for the Venture Fund developed the following strategic elements to be used in choosing investments:

- Identification of high potential/high risk areas where significant impacts might be likely, but where conventional funding sources are unlikely to invest in the near term
- Ability to leverage existing expertise and research within MIT and its research networks
- Linkage to relevant non-MIT programs
- Synergy with MIT educational goals
- Potential for public outreach, visibility, and leadership

In the past year, The Venture Fund Steering Committee selected major initiatives for the Venture Fund. In the process, a key influencing factor was identified: energy demand is increasing most rapidly in major developing countries, and MIT has numerous existing collaborative energy research activities in the largest of these, China. The Steering Committee saw two opportunities to take advantage of this strength. First, it could participate in China's efforts to improve energy efficiency in buildings. Second, it could help China improve the safety and reliability of its rapidly expanding nuclear industry. The focus on the buildings project is on residential buildings in large Chinese cities beginning with Beijing and Shanghai. The Project has emphasized the use of materials and building styles appropriate and available in the local area.

With respect to nuclear energy, the project recognizes the tremendous need in China for energy sources that do not contribute so hugely to greenhouse gas emissions and the fact that the country is increasing its construction of nuclear power plants. Our project concern is with the safety of those plants. The diversity of plant designs and the rapid growth of the number of plants will stretch the nuclear industry and regulatory infrastructure to cope with the safety requirements of each design as developed in the country of origin. Should an accident occur at one of the plants, it would have severe repercussions in China and around the World. Therefore, there is a need to harmonize the safety standards among all plants, which will help ensure their reliable operation.

Education and Curriculum Initiatives
CEI carries out its educational initiatives through the Program on Environmental Education and Research (PEER) this program is directed by Professor Jeffrey Steinfeld with Education Coordinator Dr. Matthew Gardner. The objectives of PEER are to encourage multi-disciplinary educational initiatives, to strengthen existing efforts, to promote communication among faculty, students, and staff with interests in these topics, and to integrate the findings of leading-edge research into the education of every student at MIT.

The mission of the Environmental Education Program is twofold: First, it seeks to expand the environmental content in the academic curriculum, and to raise environmental awareness among MIT's population. Second, the program seeks to facilitate the development of education, training and outreach efforts among the environmental research programs. The program is dedicated to the development of increased awareness of the relationship between the academic programs here at MIT, and the world around us.

Towards this end, the program acts as a resource for faculty staff and students who are interested in developing new content for their courses and performing environmentally related research. The program also helps facilitate the development of education, training and outreach efforts.

Examples of education programs currently in progress are:

- Case study development. This effort uses ongoing environmental research efforts at MIT to provide content for the development of curricular materials. These materials will be designed to be useful in a variety of different academic disciplines, at a variety of different academic levels.
- Environmental attitude survey. The survey was designed to find out what motivates today's university students, and to determine what role they think that colleges and universities should play in educating them about environmental issues.
- International education programs. The MIT education initiative co-directs the international Youth Environmental Summit of the Alliance for Global Sustainability.
- Outreach and dissemination of environmental research results. Program is coordinating an effort to develop international distance learning programs for sustainable development with partners around the world.
- Capacity building. Organized mid-career training for decision-makers in Mexico for Mexico City Project on the environment

The environmental education program also manages two successful fellowship programs for scholars in sustainability at MIT. The Knut and Alice Wallenberg Foundation fellowship program at MIT provides two-year support for selected postdoctoral students from Sweden to work in research groups at MIT focusing on environmental and sustainability issues. The Martin Family Graduate Fellowship Program in Sustainability was established to honor graduate students across the institute working in issues of environment and sustainability. The students are nominated by the faculty and participate in numerous environmental activities including the AGS Annual Meeting and in the weekly seminar programs. In addition, this year, CEI organized a retreat for the Martin and Wallenberg Fellows to focus on sustainability issues. A generous gift from the Martin Family Foundation through Lee '42 and Geraldine Martin has led to funding for 8–10 of the Martin Fellows/year.

More information about the Center for Environmental Initiatives can be found on the World Wide Web at http://environment.mit.edu/.

David H. Marks

CENTER FOR MATERIALS SCIENCE AND ENGINEERING

The Center for Materials Science and Engineering (CMSE), an interdepartmental center at MIT, is an innovative and dynamic program in interdisciplinary materials research and education. Funded since 1994, CMSE is the largest of a nation-wide network of twenty-eight Materials Research Science and Engineering Centers (MRSEC) sponsored by the National Science Foundation (NSF).

MIT has an extraordinarily strong and broad effort in materials science and engineering involving approximately 120 faculty members in 11 departments in the schools of science and engineering. Much of the research addresses intermediate-term engineering problems, often with the participation and support of industry. However, the longer-range problems, especially those that require a multi-investigator approach, are often overlooked. In this environment CMSE has a special mission: to encourage research and education in the fundamental science of materials and in the engineering of materials for long-range applications that will meet the needs of society. To accomplish this, CMSE promotes collaboration among MIT faculty and between MIT researchers and the researchers of other universities, industry, and government and nonprofit laboratories.

Collaborative research is encouraged through several mechanisms: interdisciplinary research groups (IRGs), shared experimental facilities (SEFs) and outreach programs. The IRGs, described below, are composed of MIT faculty who, with their students and postdoctoral associates, investigate fundamental scientific questions and pathways to reach significant technological goals that can only be properly explored in a collaborative, multidisciplinary mode. These problems are too large in scope to be addressed by individual faculty members and their students. Collaboration is essential for materials-related science and engineering, even for individual investigators, because such research requires very sophisticated equipment. CMSE provides a mechanism for the purchase and supervision of such equipment in its SEFs. The equipment is made available to the members of the IRGs, individual MIT investigators, and researchers from other university, industrial, government, and nonprofit laboratories.

CMSE also provides seed and initiative funds. While preference is given to young faculty, CMSE uses seed and initiative funds to support research that has the potential of redefining the direction of an existing IRG or leading to the creation of a completely new IRG. Seed funding provides CMSE with the flexibility necessary to initiate high-risk research.

RESEARCH

This has been a year of change for the Center. In February, I began an assignment as Interim Dean of Science, replacing Professor Robert J. Birgeneau (Physics). Professor Birgeneau, a member of our Doped Mott Insulators group, was named President of the University of Toronto effective July 1, 2000. Last August, Professor Michael Rubner (Materials Science and Engineering) was appointed as the CMSE associate director and safety officer. Professor Samuel Allen (Materials Science and Engineering) left his position as our education leader to become the executive officer of the Department of Materials Science. He was replaced in this role by Professor Steven Leeb (Electrical Engineering and Computer Science). On a sad note, Professor Toyoich Tanaka (Physics), the leader of our Heteropolymers and Gels Initiative, passed away suddenly on May 20, 2000. He had been a long-time member of the Center and will be missed.

INTERDISCIPLINARY RESEARCH GROUPS

Microphotonic Materials and Structures

In the past 50 years, semiconductor technology has come to play a vital role in almost every aspect of our daily lives. In the next 50 years, our technology may be just as thoroughly revolutionized by the replacement of electrons with photons (i.e. light) as the carrier of information. Photons have several advantages over electrons, including greater speed, greater information carrying ability, and greater energy efficiency. The key to achieving this advance, and the principal goal of this IRG, is the development of an exciting new class of materials, called photonic crystals, which will allow control of the confinement and propagation of light in very small dimensions, thereby enabling the design and integration of a large number and variety of optical microdevices on a single chip.

Participating faculty and departmental affiliations: H. A. Haus, E. P. Ippen, L. A. Kolodziejski, and H. I. Smith (Electrical Engineering and Computer Science); L. C. Kimerling (Materials Science and Engineering); and J. D. Joannopoulos (Physics).

Nanostructured Polymers

This group seeks to gain a fundamental understanding of the factors that control the way complex, electronically active polymer systems organize at the molecular level. The knowledge obtained from this work is expected to make it possible to control and significantly enhance the performance of electronic, magnetic, and optical devices based on these materials. The objective of this IRG is to develop the chemistry and processing needed to control the

composition and spatial arrangement of constituents of multicomponent polymeric materials with novel electrical and optical properties.

Participating faculty and departmental affiliations: R. E. Cohen (Chemical Engineering); M. Bawendi, R. R. Schrock, and R. J. Silbey (Chemistry); and A. Mayes, M. F. Rubner, and E. L. Thomas (Materials Science and Engineering).

Electronic Transport in Mesoscopic Semiconductor Structures

The steady decrease in the size of semiconductor structures that has brought about the information age has also made it possible to study new electronic transport phenomena. Whereas classical transport theory describes the behavior of electrons in macroscopic systems (like conventional transistors), and the quantum mechanics of microscopic systems (like atoms) is reasonably well understood, the intermediate regime, termed mesoscopic, continues to reveal surprises and opportunities for novel electronic devices. In particular, whereas some mesoscopic effects are subtle, those resulting from confining electrons to reduced dimensions (in quantum dots, for example) are very dramatic. It is the goal of this IRG to understand the fundamental physical principles governing transport through and between semiconductor nanostructures created by both self-assembly and lithography techniques.

Participating faculty and departmental affiliations: R. Ashoori, M. A. Kastner, P. Lee, L. Levitov, and X.-G. Wen (Physics); M. G. Bawendi (Chemistry); and E. A. Fitzgerald (Materials Science and Engineering).

Microstructure and Mechanical Performance of Polymeric Materials

It is widely recognized by polymeric material producers that the key to polymer penetration into new product markets is through the optimization of industrial polymers on the market today. Thermoplastics offer major advantages in load-bearing applications because they are inexpensive, light-weight, easily processed into desired form, and recyclable. However, their mechanical properties limit their applicability. Recent advances in the ability to study material microstructure and deformation at multiple length scales have created tremendous new opportunities for developing methodologies for truly designing polymeric material systems. The goal of this IRG is to provide a mechanistic basis for tailoring polymer microstructure in order to achieve dramatic improvements in multiple mechanical properties by exploring and exploiting connections among microstructure, mechanisms and mechanical performance.

Participating faculty and departmental affiliations: A. S. Argon, M. C. Boyce, and D. M. Parks (Mechanical Engineering); and R. E. Cohen, K. K. Gleason, and G. C. Rutledge (Chemical Engineering).

Doped Mott Insulators

Several of the most interesting phenomena discovered in materials science in the past decade occur in a class of substances called Mott insulators. For example, high critical temperature (T_C) superconductivity occurs when certain copper oxide Mott insulators are doped to make them conducting. The effect of doping on the electronic and magnetic properties of Mott insulators is one of the great unsolved problems in condensed matter physics. The members of this IRG believe that the understanding of high T_C superconductivity, in particular, will require the solution of this larger problem. Apart from the intrinsic scientific interest, a deeper understanding of doped Mott insulators will pave the way for the exploitation and control of this technologically interesting class of materials

Participating faculty and departmental affiliations: R. J. Birgeneau, M. A. Kastner, T. Imai, and P. A. Lee (Physics); F. C. Chou (Research Scientist, CMSE); and R. J. Cava (Chemistry, Princeton University).

INITIATIVES

Lithium Polymer Batteries

Rechargeable Li batteries with a solid polymer electrolyte (SPE) could be the ultimate power storage device due to their high potential energy density and low cost. Li-SPE imposes no limitations on the shape of the battery and is inexpensive to process, in contrast to current battery technology based on liquid electrolytes. Development is impeded by materials problems that are difficult because of the interaction between electronic, chemical and mechanical phenomena. The members of this initiative have expertise in electrochemistry polymer synthesis and characterization, oxide synthesis and first-principles electronic structure calculations. The objective is to develop the basic science behind rechargeable Li batteries, and use it to develop superior materials for this application. Initially, the focus will be on the development of a block copolymer solid electrolyte (BCE), and a high-energy density, low-cost, intercalation oxide for the cathode. With block copolymers, a microstructure can be formed that is locally liquid-like (allowing high ionic conductivity), but globally solid-like (giving the material mechanical rigidity). To design a novel cathode intercalation oxide, the group will use first-principles calculations to determine the factors that influence the phase stability of the intercalation oxide.

Participating faculty and departmental affiliations: G. Ceder, Y.-M. Chiang, A. Mayes and D. Sadoway (Materials Science and Engineering).

Heteropolymers and Gels
This group will focus on creating and understanding these materials for the design of new classes of chemical sensors, actuators, and catalysts. Approaches to molecular recognition will include the organization of diverse functionality in the heteropolymer gels and the integration of preorganized receptor units. For catalysis, recognition sites must be developed which stabilize reactive intermediates, thereby lowering the activation energies of specific chemical reactions. In all cases, molecular recognition requires that the gel exhibit a specific global thermodynamic minimum in the polymer's conformation similar to those exhibited by enzymes. Strategies for imprinting such a global minimum in a polymer gel will be developed utilizing cross-links based on disulfide linkages and novel physical cross-links resulting from threading of a second polymer through macrocyclic linkages. The recognition properties of the gels enable chemo-activated mechanical responses. Gel actuators based upon volume transitions will also be pursued.

Participating faculty and departmental affiliations: T. Swager (Chemistry); S.B. Leeb (Electrical Engineering and Computer Science); and A.N. Berker, and T. Tanaka (Physics).

SEED PROJECTS
The center funded the following seed grants during the 1999–2000 year. The participating faculty and departmental affiliations follow the project title.

- *In Situ* Nuclear Magnetic Resonance (NMR) of Polymeric Material under Active Deformation, Karen Gleason (Chemical Engineering)
- Surface Directed Self Assembly for Micro- to Nanoscale Fabrication of Electroactive Devices, Paula Hammond (Chemical Engineering)
- Nanoscale Dynamics of Structured Polymers and Colloids Studied by X-ray Photon Correlation Spectroscopy, Simon Mochrie, (Physics)
- Phonon-Polaritonic Bandgap Crystals, Keith Nelson (Chemistry)
- Current Contrast Microscope of Mesoscopic Devices, Rajeev Ram (Electrical Engineering and Computer Science)
- Magnetic Properties of Nanostructured Polymers, Caroline Ross (Materials Science and Engineering)

During the course of the year, the seed research of Karen Gleason was incorporated into the IRG on Microstructure and Mechanical Performance of Polymeric Materials.

COLLABORATION WITH INDUSTRY AND OTHER SECTORS
CMSE collaborates with other laboratories and centers at MIT that carry out materials-related research and engineering with direct involvement of industry and other sectors, and CMSE facilities are modified in coordination with these organizations to assure that the overall spectrum of facilities offered by MIT is as broad as possible without unnecessary redundancy.

The SEFs are a critical feature of CMSE's collaborations with non-MIT personnel. The facilities are made available to any researcher from a nonprofit institution and to industrial researchers when equivalent facilities are not available commercially. During the past year, CMSE facilities have been utilized by 13 commercial organizations and 16 outside academic institutions. The CMSE/IBM X-ray participating research team (PRT) at the National Synchrotron Light Source (NSLS) at Brookhaven and the CMSE/Whitehead Institute/IBM/McGill (CAT) under development at the Argonne Advanced Photon Source (APS) are very special facilities constructed and operated with direct industrial and government laboratory collaboration. These PRTs and the neutron diffraction PRT at the National Institute of Standards and Technology (NIST) provide users from all sectors with access to those facilities. Finally, several of the IRGs participate in direct research collaboration with industry and other sectors. This is important for exchange of knowledge and the education of graduate students, for it provides them with direct experience of industrial research.

EDUCATION, HUMAN RESOURCES, AND OUTREACH
CMSE's programs contribute to the education of both undergraduate and graduate students in a variety of ways. Joint programs with the Materials Processing Center (MPC) and the Office of Graduate Education bring undergraduates from all across the nation to MIT in the summer to become involved in materials research. The SEFs are also important in undergraduate education. Courses, such as those in X-ray scattering and electron microscopy, teach students to use processing and characterization facilities and to carry out research projects using the equipment. A course entitled Materials Synthesis and Processing, taught by the Department of Materials Science and Engineering and initiated with partial NSF support, uses the SEFs extensively. In addition, short courses are taught

using the facilities during the Independent Activities Period. At the graduate level, CMSE plays a critical role in the education of almost all the students at MIT who do materials-related research. The CMSE colloquium series provides an opportunity for graduate students from many departments to learn about the broad range of research activities. In addition to students directly involved in the research of the IRGs, the shared facilities are used by graduate students from 11 academic departments.

AFFIRMATIVE ACTION

CMSE is committed to providing opportunities to women and minorities through hiring and educational and research programs. During the past year, one female senior staff assistant left the CMSE headquarters staff. Other staff changes included the addition of a male postdoctoral associate and the departure of a male research affiliate. Of the seventeen students who participated in the CMSE Undergraduate Research Opportunities Program, funded by the National Science Foundation as part of the MRSEC Program, five are women and twelve are men. Two of the UROP students are African-Americans.

The center offers three different programs that bring researchers to MIT during the summer. For the seventh year, CMSE and the MPC jointly sponsor a ten-week internship program. Ten interns were selected from applications submitted by approximately 150 undergraduates from other universities around the country. Five of these scholars are women, and one is a Pacific Islander. The interns include Rebecca Boudreaux (University of Southern Mississippi), Hsin Chiang (University of Illinois at Urbana-Champaign), Stephanie Connor (Iowa State University), Adrian Fehr (University of Washington), Meghan Kerner (Case Western Reserve University), Adam Nolte (University of Missouri-Rolla), Bradley Peterson (University of Maryland Baltimore County), Nicole Seiberlich (Yale University), George Tripp (Utah State University), and Patrick Underhill (Washington University). CMSE also sponsors two Hispanic undergraduates participating in the Graduate Education Office's MIT Summer Research Program. Both José Méndez-del Rio and Miguel Angel Vescovacci are students at the University of Puerto Rico-Mayaguez. The third program, Materials Research Experience for Teachers, brings three science teachers to campus for seven weeks to work with MRSEC faculty members and their research groups. Lori Robb and Edward Rice are seventh- and eighth-grade science teachers in Cambridge public schools, and Sean Müller teaches chemistry at Merrimack High School in New Hampshire.

For the eighth year, the center operated its successful science and engineering day camp for seventh- and eighth-grade students, most of whom are members of underrepresented minority groups. During the summer of 1999, the program hosted 17 students from two Cambridge public schools. The students included fourteen who are members of underrepresented minority groups. Thirteen of the students are girls and four are boys. The students were supervised by volunteer faculty and staff, as well as MIT undergraduates Van Kennedy Clary, Patricia Diaz, Hsingching Hsu, Amy Lin, Rafael Mandujano, and Autumn Zhang.

We continued the CMSE graduate minority research assistant (RA) program to support the development of doctoral-level scientists and engineers in the field of materials. During the 1999–2000 academic year, the center provided RA support to two male graduate students who are members of underrepresented minority groups, one in the Department of Electrical Engineering and Computer Science and one in the Department of Mechanical Engineering. In addition, seed funding was granted to one minority female faculty member working in the field of materials science and engineering.

More information about the Center for Materials Science and Engineering can be found on the World Wide Web at http://web.mit.edu/cmse/www/.

Robert J. Silbey

ENERGY LABORATORY

The Energy Laboratory and its associated Center for Energy and Environmental Policy Research (CEEPR) are multi-disciplinary organizations bringing together sectors of the MIT community with research interests related to energy supply, conversion, and utilization technology, as well as associated environmental, political, economic, geographical, and societal impacts. Professor Jefferson Tester is the Director of the Energy Laboratory and is supported by Associate Director Dr. Elisabeth Drake, Associate Director Dr. William Peters, and Administrative Officer John O'Brien. Professor Paul Joskow, with Dr. A. Denny Ellerman, Executive Director, directs the CEEPR. For more than 25 years, the Energy Laboratory has sustained a unique organizational structure to develop and implement strong single- and inter-disciplinary energy-related work at MIT. It provides a variety of research opportunities for students at all levels—from the Undergraduate Research Opportunities Program to postdoctoral studies. Our research programs in FY2000 supported about 125 undergraduate and graduate students, along with about 60 associated faculty members from twelve academic departments representing all five of MIT's Schools.

HIGHLIGHTS

Our graduate elective, Sustainable Energy (22.811J/10.391J/ESD66/11.371J/1.818J/3.564J), was offered for the fourth time in the Spring term. The course was taught collaboratively by members of the Energy Laboratory and the Nuclear Engineering and Chemical Engineering Departments, with participation of other experts from within and without MIT. Students from all of MIT's Schools, including several from the MIT ESD and one from Harvard, completed the course, which included quantitative problem sets, topical papers and student-led recitations. The course instructors are preparing a new textbook for the course, which will be beta-tested in draft in 2001.
The Energy Laboratory research volume for FY2000 was over $8 million, including sponsored research and fund accounts.

The initial phase of the "Clean Diesel Fuel Research Initiative Program," collaboration between the Energy Laboratory (Sloan Automotive Laboratory) and the Chemical Engineering Department under the University of Alaska-MIT Partnership, received substantial industry support. The initial goal is to identify and assess the potential for significantly cleaner diesel fuels. A proposal on a longer-term research program has been developed.
The Energy Laboratory and the Nuclear Engineering Department have jointly developed a new Center for Advanced Nuclear Energy Systems (CANES). The center aims to create through research concepts for nuclear energy systems that promise more favorable economics, safety, proliferation resistance and environmental impact. The Center's programs involve development and application of methods for the design, operation, and regulation of current and advanced nuclear reactors and fuel cycles. This requires advances in knowledge about traditional scientific and technical disciplines, modern methods of systems reliability, probabilistic safety analysis and decision analysis, together with human interactions and management science. The center will start operation in September 2000 with Professor Mujid S. Kazimi as its first Director.

CEEPR initiated two new activities in the 1999–2000 academic year. The center received funding to begin research to assist in the design of a SO_2 cap and trade system for China as part of a cooperative agreement between the U.S. and Chinese governments. The center also held it first policy workshop in Europe in conjunction with Hidroelectrica del Cantabrico in Oviedo, Spain, on the subject of electric utility sector restructuring.

The Joint Program on the Science and Policy of Global Change continues to gain recognition as a leading center of research in its field. This recognition comes not only in the form of new associates and the continuing flow of financial support, but also in the form of more invitations to participate in expert reviews and assessments and to speak or otherwise participate in various meetings. In the past year, research and peer-review lags have been overcome and Joint Program research is appearing in a number of different journals, such as *Nature, Climatic Change, Journal of Climate, Foreign Affairs, the Review of Economics and Statistics*, and the *Energy Journal.* In the past year, about a dozen articles were published and another ten were accepted for publication.

We are continuing leadership work relating to technologies for carbon dioxide mitigation through carbon sequestration. We contributed to a major DOE report *Carbon Sequestration: Research and Development* (December 1999) and co-authored a paper on carbon sequestration for *Scientific American* (February 2000). Several research projects are on-going, including our participation in the International Collaboration on CO_2 Ocean Sequestration, a field experiment to take place in Hawaii in the summer of 2001. On July 1, 2000, we launched our Carbon Sequestration Initiative, an industrial consortium with seven charter members: American Electric Power, BP Amoco, Ford Motor Company, General Motors, Norsk Hydro (Norway), Texaco and TotalFinaElf (France). Finally,

we were one of three universities asked to submit a proposal to BP Amoco for a major new research program on carbon management (we eventually lost out to Princeton).

The Energy Choices Program continues to pursue three major initiatives relating to its goal of seeking environmentally friendly energy technologies for a greenhouse gas-constrained world: the first is Eco-efficient Buildings for China, under the leadership of Professor Leon Glicksman and in collaboration with Tsinghua and Tongii Universities and building developers at three locations in China; the second focuses on Nuclear Safety and Reliability Guidance for China, led by Professor Mujid Kazimi, with collaborations with Tsinghua University and other nuclear safety groups in China; and the third investigates Road Transportation Options for the Future, under the leadership of Professor John Heywood and Dr. Malcolm Weiss. A recent fourth initiative, funded by ABB Ltd. through the AGS, is the China Energy Technology Project, which examines responsible energy sector development for Shandong Province. A basic research activity involving Professors Greg Stephanopoulos and Tony Sinskey to investigate biotechnology applications to the energy industry is also continuing.

SELECTED CURRENT ACTIVITIES

Many of the laboratory's projects involve quantitative and cross-disciplinary study of complex energy and environmental systems. The Sloan Automotive Laboratory, directed by Professor John Heywood with participation from Professor Wai Cheng, Professor Doug Hart, Professor James Keck, Dr. David Schmidt, Dr. Tian Tian, Dr. Victor Wong and Professor William Green of the Chemical Engineering Department, continues promising research to improve engine performance, efficiency, and fuel utilization in internal combustion engines and reduce adverse emissions. Focusing on new engine and fuel technologies, the Engine and Fuels Research Consortium continues to explore critical fuel-air mixture preparation and emission formation mechanisms in developing engine concepts, with potential application to both gasoline and diesel engines. Complementing the engine and fuels studies, the Consortium on Lubrication in Internal Combustion Engines, involves major engine component and lubricant manufacturers, in addressing issues in oil consumption and engine friction reduction. Some members in these consortia also sponsor separate research projects on related topics of specific application to the individual sponsors. For example, Professors Wai Cheng and John Heywood work with Ford Motor Company on three projects related to engine transients: fuel-air mixture preparation behavior during start-up, emission benefits of engine operation in hybrid electric vehicles, and actual in-use vehicle emissions in stop-and-go traffic. Sloan Laboratory researchers are also involved in assessing new vehicle and propulsion system technologies for future road transportation use. The Sloan Laboratory also engages actively in basic combustion research on advanced engine systems with US DOE support, and in engine emission research with support from the EPA Research Center on Airborne Organics. The initial phase of the "Clean Diesel Fuel Research Initiative Program," a collaboration between the Energy

Laboratory and the Chemical Engineering Department under the University of Alaska-MIT Partnership, is receiving substantial industry support. The initial goal is to identify and assess the potential for significantly cleaner diesel fuels. Plans for a longer-term research program have been developed and are expected to be funded shortly. The proposed research will complement extensive fuel testing programs being conducted elsewhere and will address: Engine Technology/Fuels Interaction; Fuel Processing Technology; and Special Environmental and Economic Factors.

The Energy Laboratory interacts closely with the Center for Environmental Initiatives (CEI—directed by Professor David Marks) through several major sustainable energy initiatives described later in this section. Administrative duties are also provided to the CEI by the Energy Laboratory staff. Other interactions include the Building Technology program (led by Professor Leon Glicksman) in research on energy efficient, "healthy" buildings. Another collaboration with the Center for Environmental Health Sciences (CEHS—directed by Professor William Thilly) seeks to determine how combustion emissions and effluents from treatment of hazardous wastes may lead to adverse human health impacts. The Energy Laboratory is an active member of the Program for Environmental Education and Research (PEER) under the leadership of Professors Jeffrey Steinfeld and Philip Gschwend.

The Energy Laboratory held its third Fall workshop for participants and sponsors of the program on *Energy Choices in a Greenhouse Gas (GHG) Constrained World.* This initiative is an outgrowth of collaboration with the Joint Program on the Science and Policy of Global Change (co-directed by Professors Henry Jacoby and Ronald Prinn) to improve the technology characterizations in their Integrated Global Systems Model, as well as from growing concerns about the role of present and future energy choices on the local, regional, and global environment. Under the leadership of the CEI and its role in the Alliance for Global Sustainability (AGS), a collaboration between MIT, Eidgenössische Technische Hochschule (ETH—Switzerland), and the University of Tokyo, the *Energy Choices Program* interfaces with the Joint Program and other AGS activities. This year the focus was on the road

transportation options for the future. At present, the program has received funding from the AGS, five industrial sponsors, and the V. Kann Rasmussen Foundation, which has established the *MIT Venture Fund for Energy Choices*, to facilitate the development of the larger program, committing funding of $2.35 million over a four year period. Several *Energy Choices* research activities are underway:

- Faculty and students in Building Technology are conducting a major program of sustainable building design and technology for developing countries. We are actively cooperating with colleagues at Tsinghua University and Tongji University and Chinese developers and designers. Our focus is on residential buildings in large Chinese cities. Projects include the design of four high-rise residential structures in Beijing, two mid-rise multi-story housing units in Shanghai's Taidong Residential Quarter, and a low-rise residential community in Shenzhen City. The goal of these projects is the development of demonstration buildings that use appropriate technologies and designs as a teaching tool and example for future projects in Chinese cities. New technologies are being evaluated such as night cooling, solar driven dehumidification, and ground coupled heat pumps, as well as incorporating traditional technologies such as shading and natural ventilation. Schematic designs for the three developments will be completed during Summer 2000.
- The Building Technology group also is cooperating with colleagues at the University of Tokyo in a study dealing with reduction of pollution from megacities such as Tokyo or Shanghai. This technical work is being carried out in cooperation with the University of Tokyo and the Swiss Federal Institute of Technology. In this project, technologies such as ground source heat pumps and advanced facades are being evaluated. Ground source heat pumps use low-grade geothermal energy to improve efficiency for both heating and cooling of buildings. The ground source air conditioner, which stores or extracts heat underground, will significantly reduce urban heat island effects in the summer. We have undertaken a comprehensive study of advanced building facades that have air circulation between multiple glazing as well as blinds to control solar input and daylighting. These facade systems, when properly used, will reduce energy for air conditioning as well as artificial lighting. They will also improve interior comfort and ventilation.
- Professor Kazimi is leading a collaboration with other faculty members at MIT and Tsinghua University that aims to provide China's growing nuclear energy sector with a firmer foundation for development of nuclear safety standards. That includes the evolution of the list of design basis accidents to be more risk informed, and the application of innovative technologies for safety monitoring of plant operations. In April of 1999, the project organized a major international workshop on these subjects in Beijing. Visits to operating nuclear plants in China are planned for the coming year to share some of the international research findings and develop collaborations that will improve performance and safety.
- Professor Heywood and Dr. Weiss have completed the first phase of an assessment of new vehicle and fuel technologies for future road transportation, considering the increasing concerns about limiting both greenhouse gas emissions and criteria pollutants such as particulates and nitrogen oxides. The work started with a critical review of existing assessments (many of which are partial system views with a variety of different assumptions), and then conducted a life cycle assessment of potential fuel/vehicle systems for the 2020 time frame. Finally, the implications of transitions to these future transportation technologies to each of the major stakeholders in the transportation industry, including customers and the government, were evaluated. The focus is to identify barriers and opportunities for accelerating the adoption of such new technologies where they offer advantages relative to the evolving fleets of cars and trucks. A draft report is currently in peer review and will be published later in 2000, following an interactive workshop that focuses on the report and tries to identify responsible pathways for the future.
- The AGS *China Energy Technology Program* (CETP), where Swiss, Japanese and Chinese colleagues, along with the *Analysis Group for Regional Electricity Alternatives* (AGREA) team are helping Shandong Province identify and develop environmentally responsible electric sector development strategies.
- Professors Sinskey and Stephanopoulos continue to receive seed money under the Energy Choices Program to conduct preliminary studies on technology platform development for the applications of metabolic engineering to the energy industry. This research is part of a larger program that includes additional sources of funding within the chemical engineering department.

Professor Jack Howard directs the EPA Center on Airborne Organics. A major goal of this center is to better understand pollution of ambient airsheds by energy and other industrial sources and to use that understanding to prescribe new means of detecting and tracing organic pollutants and new methodologies for preventing pollutant emissions altogether. Specific projects focus on sources, atmospheric transport and transformation, monitoring, and engineering controls for organic pollutant vapors and aerosols. To provide a strong group of experts to address these issues, the center operates as a consortium of MIT, the California Institute of Technology, and the New Jersey

Institute of Technology. Professors John Seinfeld (Caltech) and Robert Pfeffer (NJIT) are associate directors. MIT scientists participating in Center research projects include Professors Paul Barton, William Green, John Heywood, Jack Howard, Mario Molina, John Vander Sande, and Dr. Arthur LaFleur. For several years, the Center has hosted an annual Summer Symposium on high visibility technology and policy topics in ambient air pollution. In June 2000, the focus of this meeting was on *The Future of Diesel: Scientific Issues*. The meeting was chaired by Dr. Robert Slott, Consultant to the Energy Laboratory. Presentations and panels first addressed the present status of diesel fuel, engine technology, and emissions monitoring and regulation in the US, Europe and Asia; next the issues involved in moving to "clean diesel" were discussed; a health effects and risk assessment panel focused on the present state of knowledge and uncertainties about the effects of diesel technology, and a closing session examined the likely roles of diesel in the future.

The field of carbon management and sequestration is attracting much interest due to increasing concerns about global climate change. Our continuing work on carbon sequestration technologies focuses on three areas: assessment, education/outreach, and basic research. Howard Herzog leads this effort. We have five projects under this heading:

- On-going assessment and outreach work for the National Energy Technology Laboratory (NETL) of the DOE (in collaboration with Dr. Drake).
- An integrative assessment of carbon sequestration technologies co-funded by the DOE's Office of Fossil Energy and Office of Science (includes collaboration with Professor Jacoby and the Joint Program).
- An international collaborative effort between Japan, Norway, Canada, Australia, and the United States on CO_2 Ocean Sequestration funded by NETL. The objective of this project is to investigate the technical feasibility, and improve understanding, of the environmental impacts of CO_2 ocean sequestration. A field experiment will take place in the summer of 2001 off the Kona Coast of Hawaii (in collaboration with Dr. Eric Adams of the Parsons Laboratory).
- Participation as a member of the National Center for Research on Carbon Sequestration in the Ocean, funded through the DOE's Office of Science through Lawrence Livermore National Laboratory (in collaboration with Dr. Eric Adams of the Parsons Laboratory and Professor Bernhardt Trout of Chemical Engineering).
- The Carbon Sequestration Initiative, an industrial consortium on Carbon Management under the Energy Choices Program. Our seven charter members are: American Electric Power, BP Amoco, Ford Motor Company, General Motors, Norsk Hydro (Norway), Texaco and TotalFinaElf (France).

The University Research Consortium (URC) of the DOE Idaho National Engineering and Environmental Laboratory (INEEL) has continued to support research projects at MIT, primarily in nuclear technologies, under the new contractor, Bechtel, which took over management of INEEL in October 1999. With support from the URC, a three-year program was initiated in October 1998 for development of advanced nuclear technology through an MIT/INEEL Strategic Nuclear Research Collaboration (SNRC). The aim of the SNRC is to investigate options that promote nuclear technology as a source of electricity in the next century. In its second year, the program had a total funding at MIT of $1.2 million per year tied with about $1 million funding at INEEL. Four projects were funded under this initiative: The Modular Gas Cooled Reactor (MPBR) under the direction of Professors Andrew Kadak and Ronald Balinger; The Lead-bismuth Cooled Actinide Fueled Reactor (AFR) under the direction of Professors Todreas and Kazimi; Advanced Fuels for Light Water Reactors under the direction of Professors Kazimi and Driscoll; and Methodology of Performance-Based Regulation under the direction of Professors Apostolakis and Golay.

A major collaborative program was started in 1985 between MIT and the INEEL, with funding from DOE Basic Energy Sciences. Today this collaboration seeks new engineering understanding to improve efficiency and materials conservation in energy-intensive processes. Dr. Drake manages the MIT portion of the program, with one project led by Professor David Parks and another by Professor Thomas Eagar. The present project cycle will continue to fund the collaborative research through the end of calendar year 2003. The annual review meeting was held at the MIT Energy Laboratory in June 2000.

With DOE funding, in the Heat Transfer Laboratory, Professor Glicksman and students are carrying out studies of heat transfer and hydrodynamic scale-up in fluidized bed combustors. An experimental scale model of a large scale commercial fluidized bed has been operated to study overall flow behavior. This will provide design guidance for a larger scale commercial unit. The commercial unit promises to achieve overall thermal efficiency of 50 percent or higher. This unit will also control the emissions when dirty fuel is burned. A key problem in the design of fluidized

bed combustors is the proper sizing of heat transfer surface area. These fundamental studies will allow accurate prediction of the heat transfer to the bed walls. Recent research has focused on measuring the turbulence in the bed; this is the key to understanding the transport of particles from the bed core to the heat transfer surfaces at the wall.

Research in competitive power systems continues to advance. Led by Dr. Marija Ilic, research in this area includes the consortium *New Concepts and Software for Competitive Power Systems: Operations and Management*, and the ABB sponsored *Distributed Power Industry of the Future* project. Mr. Stephen Connors helps coordinate the Competitive Power Systems group's activities. Funded by ABB, Constellation Power Source, Electricite de France, TransEnergie U.S. and the Department of Energy's Energy Information Administration, the *New Concepts* consortium is devising techniques for market players and market monitors to work effectively in a competitive electric industry. Research thrusts include the development and application of congestion management structures and computational capabilities for regional grid operators, price-forecasting techniques for generators and power marketers, and revised criteria for measuring the adequacy and reliability of power supplies. The *Distributed Power Industry* project focuses on the technical, economic and regulatory challenges that distributed resources pose to distribution system stability. The project, that will hopefully evolve into a consortium in the coming year, is also addressing alternative business models and regulatory structures, which may enable, or constrain, the deployment and use of consumer-based electricity generation, storage, demand control and power quality enhancement. Also participating in the Distributed Power project are Professors Paul Kleindorfer from the University of Pennsylvania's Wharton School of Business, and Ingo Vogelsang from Boston University. The Energy Lab's contributions in these areas have been magnified by Dr. Ilic's part-time efforts at the National Science Foundation, in the Electrical and Communication Systems Division. As Program Director for Power and Energy Systems, Dr. Ilic has participated in many academic, professional, industry conferences and workshops, and helped shape the national debate on the future of power systems research, education and practice.

Energy Lab research in the area of strategic planning for energy infrastructures and environmental performance is led by Mr. Stephen Connors. The scenario-based multi-attribute tradeoff analysis approach, developed in the 1980's Energy Lab researchers, is the primary tool used by the Energy Lab's Analysis Group for Regional Electricity Alternatives (AGREA). Current AGREA projects include studies of Switzerland's, China's and Romania's electricity alternatives, as well as an integrated assessment of the air pollution reduction alternatives for the Mexico City Metropolitan Area. The electricity planning efforts are under the sponsorship of the multi-university Alliance for Global Sustainability, which involves researchers from Switzerland and Japan. While the Swiss case study is nearing completion, the Shandong Province, China case study is now in its second year, with the Romanian case just getting underway. In addition to the multi-attribute tradeoff analysis approach, all three case studies are designed to interact with local decision-makers to ensure the research is relevant, attuned to local conditions, and have a better chance of influencing the decisions of local officials. This is true also of the Mexico City case study. This project, sponsored by the Consortium on Environmental Challenges, includes numerous Mexican institutions and researchers, as well as scientists from the Harvard School of Public Health. On the MIT side, researcher are drawn from the Departments of Earth, Planetary and Atmospheric Sciences, Civil and Environmental Engineering, Chemical Engineering, and Urban Studies and Planning, and labs and centers such as the Energy Lab, The Center for Transportation Studies and the Center for International Studies. AGREA plays a central role in this effort due to its scenario planning approach, and extensive experience in interacting with local stakeholders.

The Energy Laboratory continues a program of scientific and engineering research to support technologies for destroying military and other hazardous wastes by supercritical water oxidation (SCWO). MIT studies provide new understanding of various important practical issues including kinetics of waste destruction, corrosion prevention, phase equilibria, salt transport and deposition, reactor modeling, and process simulation. Recent work in collaboration with a small business in the computational fluid dynamics sector has focused on development of mathematical models for SCWO reactors (U.S. Army STTR funded). Another Army-funded project focuses on studies of the kinetics of waste destruction. Related MIT projects are concerned with the use of supercritical fluids as media for "green chemistry" and to reduce emissions from diesel engines. MIT research on supercritical fluids is led by Professor Tester and has involved Professors Tomas Arias (now at Cornell), David Cory, Rick Danheiser, Peter Griffith, Jack Howard, Ronald Latanision, Kenneth Smith and Jeffrey Steinfeld, Dr. Michael Modell, Dr. William Peters, Mr. Howard Herzog, and Dr. Frederick Vogel, as well as visiting faculty from Merrimac College, Professors Angelike Rigos and Katherine Swallow.

CEEPR AND JOINT PROGRAM

The Center for Energy and Environmental Policy Research (CEEPR) is an activity, jointly sponsored at MIT by the Energy Laboratory, the Department of Economics, and the Alfred P. Sloan School of Management, that funds policy-related research in energy and environmental economics. The Center and the Joint Program receive financial support from corporate sponsors, government agencies in the U.S. and Norway, and one foundation. In addition, affiliate relations are maintained with several environmental groups and other policy-oriented research groups in other countries.

For the past several years, CEEPR's principal research activity has been conducted under the auspices of the Joint Program on the Science and Policy of Global Change, sponsored in collaboration with MIT's Center for Global Change Science. This program, led by Professors Jacoby and Prinn, draws on MIT's traditional strengths in science and economics to conduct the serious interdisciplinary work needed to provide a basis for global climate policy. The now seven-year-old Joint Program is one of the world's leading centers for the Integrated Assessment of Climate Change. The Integrated Global Systems Model provides the basis for a number of reports, articles, and presentations on the science and policy of global warming. The principal faculty and researchers are frequently requested to attend scientific and expert group meetings related to climate change. Contributions to the Joint Program remain stable with annual funding now approximately $2.8 million. The work of the Joint Program is supported financially by a number of corporate sponsors in North America, Europe and Japan, the US governments and the Vetlesen Foundation.

CEEPR research outside of the Joint Program has focused on four areas: emissions trading; electricity markets; productivity improvements in the supply of energy; and energy futures, forwards and arbitrage. By merit of its research on the U.S. SO_2 emissions trading program, the Center has become an authority on the actual functioning and implementation of emissions trading as an instrument for the more efficient achievement of environmental goals. As an example, CEEPR is assisting in the design of a SO_2 cap and trade system for China under a cooperative agreement between the Chinese and U.S. governments. As the electric utility industry is being restructured in many countries, markets in electricity are emerging for the first time. CEEPR's research examines the functioning and performance of these new markets. Particular emphasis is placed on how restructuring decisions with respect to asset ownership, transmission access, and customer choice shape these markets. The work on productivity is concerned with determining the sources and causes of the remarkable improvements that have occurred over the past 10–15 years in the supply of conventional hydrocarbon energy supplies. Most of the current work has been concerned with coal; however, with the cooperation of the Norwegian government, this research is being extended to cover oil and gas, using the North Sea as a case study. Finally, research on energy futures, forwards and arbitrage applies an area of expertise at the Sloan School to the emergence of highly liquid spot, futures and forward markets for crude oil and natural gas and to the current development of such markets for coal and electricity.

NEW INITIATIVES

We have formally launched the Carbon Sequestration Initiative (CSI), our industrial consortium on carbon management with a founding group of seven organizations. The CSI will function as a facilitating web information network for members and also will seed selected relevant innovative research ideas.

In the area of supercritical fluids, we are expanding our emphasis from research in support of waste destruction/decontamination to chemical synthesis and other applications that capitalize upon the remarkable solubilizing power, phase relationships, and species transport behavior of fluids near and above their critical point. A new industrially-supported project in this area will begin in July 2000.

In the area of electrothermal (plasma) processing, we plan to further pursue applications to problems in extractive metallurgy, wastes recycling, and conversion of biomass as well as fossil fuels. Our plasma work has attracted significant industrial interest including research funding. In support of plasma processing and other applications (propellant combustion, CO_2-metal propulsion systems for Martian atmospheres), we also plan to explore NASA and DOD interest in our capabilities to study the kinetics of gaseous reactions with metal vapors and metal droplets at temperatures in the 2000 to 3000 K range.

More information about the Energy Laboratory can be found on the World Wide Web at http://web.mit.edu/energylab/www/energylb.htm.

Jefferson W. Tester

FRANCIS BITTER MAGNET LABORATORY

The Francis Bitter Magnet Laboratory (FBML) has continued to make notable advances in several areas of science and engineering involving high magnetic fields. The research program in Magnetic Resonance (nuclear magnetic resonance (NMR), and electron paramagnetic resonance (EPR)) has continued to grow and remains the largest effort at the FBML. The program is funded primarily by the NIH and DOE, and involves ~20 NMR and EPR magnets and spectrometers.

A few of this year's highlights include the following.

Professor Robert G. Griffin, together with Professor Gerhard Wagner of Harvard University, continue to operate The MIT/Harvard Center for Magnetic Resonance, a collaborative research effort between MIT and Harvard Medical School. The Center is supported by a NIH Research Resource grant that was renewed for five years.

Professor Harald Schwalbe joined the Department of Chemistry in October, 1999. His offices and laboratory space are presently located at the FBML. Professor Schwalbe's area of research is focussed on solution NMR studies of protein folding and structures of ribonucleic acids.

Professor Cory and his colleagues continue to make rapid advances in the theory, practice and implementation of quantum information processing. In collaboration with Bruker Instruments, Inc., they have helped to develop and taken delivery of the first special-purpose commercial NMR designed for quantum information processing. They are now constructing a second-generation quantum processor that is designed to reach more than 10 qubits.

Dr. Yukikazu Iwasa received funding from NIH to construct a very high field, wide bore 700 MHz NMR system. The system is essentially complete and has successfully passed most test and we anticipate delivery in a few weeks. A unique feature of the magnet is a ±500 Gauss sweep coil essential for dynamic nuclear polarization experiments.

Dr. Jagadeesh Moodera has continued to strengthen his research efforts in condensed matter physics through collaboration with various universities and industries, as well as the ONR and NSF. In addition, he has continued his mentoring of graduate students, undergraduate and high school students by providing research opportunities within his lab. Dr. Moodera received the 2000 TDK Research Award for his pioneering studies in spin tunneling.

RESEARCH ACTIVITIES

Professor David G. Cory's research activities include the following:

- Quantum Information Processing (QIP). Professor Cory continues to explore NMR approaches to quantum information processing through a set of collaborations with Dr. T. Havel (HMS), Professor Seth Lloyd (Mechanical Engineering), Dr. Raymond Laflamme (LANL), Dr. E. Knill (LANL) and Dr. J. Yepez (AFRL). Much of our recent efforts have been directed to making liquid-state NMR implementations of quantum information processing robust at the level of 5 to 7 qubits. They have also articulated two new schemes for extending the success of NMR approaches to QIP to larger systems and have started to build a solid-state device capable of coherently controlling 10 ñ 30 qubits, which will have the unique feature of a resettable qubit. This is essential for exploring quantum error correction.
- NMR of heterogeneous semi-solids. In collaboration with Dr. S. Singer, and Dr. Pabitra Sen of Schlumberger Doll Research Laboratory, Professor Cory has continued to explore the structure and fluid dynamics of complex media. This is facilitated by a series of recently developed methods that permit the separation of the pore structure factor from the incoherent fluid motion. They have shown that the NMR signal (after suitable averaging and manipulation) provides a fingerprint of the sample geometry and that much of the inverse problem can be solved. Applications are expected in both biology and in granular or porous media.
- NMR imaging of fluid transport through granular media. In collaborations with Professor Culligan (Civil and Environmental Engineering) and Professor Czerwinski (Nuclear Engineering), the transport of lanthanides and the displacement of contaminants in model sands, soils and resins are being studied by NMR. For resorcinol resins (used to trap metals) the NMR results provide a clean and unambiguous measure of bound, plasticizer and free water ñ including their exchange properties.

Professor Robert G. Griffin's research acitivities included the following:

- High Frequency Electron Paramagnetic Resonance (EPR). About a year ago the capabilities of the 140 GHz EPR spectrometer were dramatically extended by the incorporation of a four-phase microwave pulse-forming network and amplifier with 30 mW of output power. Professor Griffin has just received funding for a further upgrade to ~110 mW. The greater microwave power and phase switching capability allows us to develop and perform sophisticated pulsed EPR techniques. In particular, his group is working on developing new pulsed methods for spectral filtering, electron/nuclear cross polarization and multiquantum EPR experiments for measuring long-range distances (10-30 Å) in spin labeled proteins and peptides. In addition, the 140 GHz pulsed Electron-Nuclear Double Resonance (ENDOR) capability has already been used to examine a number of systems. For example, the increased sensitivity, resolution, and orientation selection available in the ENDOR experiment at this high frequency/field has enabled us to determine in detail the electronic structure of the tyrosyl radical of ribonucleotide reductase. (RNR) ENDOR studies of the RNR inhibitor complexes.
- Structural Studies of Alzheimer's Disease Amyloid. Amyloidoses are a group of peptide or protein misfolding disorders characterized by the accumulation of insoluble fibrillar protein material in extracellular spaces. Sixteen different peptides are known to form amyloid-like aggregates. The aggregation of these peptides is involved in several diseases. ß-amyloid (Aß) is involved in Alzheimer's disease, the conversion of the prion protein PrPc to PrPsc leads to the transmissible spongiform encephalopathie, and the synuclein protein is responsible for Parkinson's disease.
- During the last two years, Professor Griffin's lab has worked on methods to obtain large amounts of fibrillar peptide material. Fibril preparation is crucial for obtaining narrow lines, maximizing spectral resolution, and optimizing signal intensities. Fibril formation is also important for the biological relevance of the structural model. Furthermore, we have obtained $^{13}C/^{15}N$ labeled Aβ1-40 and prepared fibrils of this material. High-resolution AFM (Atome Force Microscopy) images indicate that this fragment forms regular fibrils as well and our first $^{13}C/^{15}N$ MAS spectra reveal resolved a few resonances. During the coming year, we are planing serious structural studies of the Aβ peptide.

A web site describing some of Professor Griffin's research can be found at http://web.mit.edu/fbml/cmr/griffin-group/.

In addition, Professor Griffin's group has underway studies of smaller fibrillar peptides in collaboration with Prof. Chris Dobson of Cambridge University.

- Dynamic Nuclear Polarization. During the past year they have operated the 250 GHz gyrotron on a routine basis and have initiated high frequency DNP experiments with the device. The DNP/NMR spectrometer consist of 125 mm bore 375 MHz NMR magnet and a new spectrometer console is being assembled for these experiments. The initial results indicate that we will achieve substantial signal enhancements at this frequency. At present these represent the highest frequency DNP experiments ever performed, and more importantly suggest that even higher frequency operation will be successful. Thus, in collaboration with the PSFC they are now in the process of designing and constructing a 460 GHz gyrotron that will be used in conjunction with the 700/89 widebore magnet mentioned above.
- Dipolar Recoupling. Over the last decade they have been heavily involved in the development of techniques to measure distances and torsion angles in solids. The ultimate goal is to be able to determine the structure of membrane proteins, amyloid fibrils, etc with solid state NMR. This past year we have succeeded in developing methods for performing these experiments in uniformly $^{13}C/^{15}N$ labeled molecules and we have utilized them to determine the structure of a small peptide. They anticipate that with increased signal to noise available form DNP experiments that these methods will be applicable to a large number of systems not accessible to solution NMR and X-ray crystallographic investigations.
- Center for Magnetic Resonance. The Center for Magnetic Resonance has completed its 24th year of operation as a facility open to scientists needing access to high field NMR equipment. During this year, 69 projects were worked on by 126 investigators, from departments within MIT including Chemistry, Physics and Nuclear Engineering, as well as users and collaborators from institutions outside of MIT such as Harvard University, Brandeis University and Brigham & Women's Hospital. Work resulted in 52 publications in print or in press. Highlights of work conducted at the center include advances in high frequency dynamic nuclear polarization of proteins (DNP), time resolved studies of protein folding, structures of large proteins, and high frequency EPR and ENDOR. A competing proposal was submitted to NIH for review during the summer of 1998 and is now funded for an additional five-year period.

Dr. Yukikazu Iwasa's research activities include the following:

- Dr. Iwasa's group has continued research on the key operational issue of protection for high temperature superconducting (HTS) magnets operating in the temperature range 10-60 K. In addition to this basic protection study, they have investigated practical aspects of cryocooler-cooled operation. They have studied small coils wound from silver-sheathed BSCCO-2223 tapes in the temperature range 20--60 K. they have developed a numerical NZP model for a three-dimensional, dry-wound, BSSCO-2223 superconducting magnet. The test magnet operates under quasi-adiabatic conditions at 20~K and above, in zero background field. The NZP model is based on the two-dimensional transient heat diffusion equation. Agreement between voltage traces obtained in the test magnet during heater-induced quenching events and those computed by the numerical NZP model is reasonable. The model is also used to simulate quenching in magnets similar to the test magnet.
- A new 2-year DOE-funded joint FBML-FSU/NHMFL project has started on 06/01/2000 to study stability and quench protection of YBCO wires and coils. Of particular interest to the project is the study of beneficial effects of solid nitrogen impregnated in the winding of a high-temperature superconducting coil. Solid nitrogen in the temperature range below ~60K has a heat capacity much greater than that of silver. Thus, even a small amount of solid nitrogen present within the coil winding is expected to enhance the overall heat capacity of the winding, making the coil more stable against transient heating such as that can be caused by overcurrent pulses in electric power devices.
- Also started on 06/01/2000 is a new 2-year NIH-funded project on development of a flux pump for use in a high-field superconducting NMR magnet containing a high-temperature superconducting insert coil. Because of low indices, HTS insert coils, even with superconducting splices, cannot be operated perfectly in persistent mode; their currents will decay slowly albeit at a very small rate. An HTS insert coil coupled to a flux pump can receive precisely metered quantities of energy and operate effectively in persistent mode.
- His work on developing a "permanent" HTS magnet system is nearly complete. The system combines the simplicity and ease of operation of a ferromagnetic permanent magnet with the strength, capability and versatility in field generation of an electromagnet. Once energized and producing a desired field, the system, without being coupled to a cooling source, can maintain that field for a long period. This HTS magnet is particularly suitable for an on-board or portable unit requiring a constant field and where "permanence" means a duration of hours, days, weeks, months, or even years. The system's other features are "recooling" and "recharging" capabilities designed to have the system re-cooled while maintaining its constant field to make the field literally permanent, and recharged if its upper operating temperature is exceeded and the field decays.
- An application has been filed to the U.S. Patent and Trademark Office for invention of a new high-temperature superconducting (HTS) current lead. The new HTS lead requires HTS materials that are substantially less than those required by the conventional HTS current leads available on the market. The core of the invention is that, in the new HTS current lead, a warm part of the HTS lead is operated in the so-called "current-sharing" (partially resistive) mode rather than completely in the superconducting state as in the conventional HTS current lead.

Dr. Jagadeesh S. Moodera's research activities include the following:

- In condensed matter physics, in particular magnetism, his research continues to make significant contributions to both fundamental science and industrial application. His basic investigation emphasizes interfacial exchange interaction and spin transport in thin film structures. Using his molecular beam epitaxy (MBE) system, his research seeks to contribute to the understanding of the spin properties of conventional materials and to unraveling the spin properties of certain novel magnetic compounds that have a high potential for technological application. His research in these materials has already shown the possibility of a four-level memory/logic element. Several companies, including IBM, HP, Motorola, TDK and Fujitsu, are developing this structure for application in digital storage. In this context, his group is continuing national and international collaborative research efforts with scientists and faculty from national laboratories, US universities, the University of Paris at Orsay, the University of Eindhoven, Tohoku University, the Tata Institute of Fundamental Research and the Ukrainian Academy of Sciences. Exchange of scientists and graduate students is a part of this program.
- In the area of semiconductors, our continued collaboration with Hewlett-Packard Company has been valuable in searching for far future material for atomically resolved storage (> Terabytes/in^2). He are exploring the materials with the appropriate properties and giving HP the fundamental information necessary for their program. In this direction we have been successful in identifying a possible candidate material from among thousands of compounds. There is ongoing collaboration with other companies such as NVE Inc., TDK (Japan) in the field of magnetism.

- Three postdoctoral scholars, one graduate, four undergraduate and four high school students have taken part in Dr. Moodera's research. One graduate student (from DMSE) obtained his doctoral degree. The high school students won several science competitions, including a semifinalist in Intel-Westinghouse Science Competition, as well as other regional top awards. Notably, one high school student who participated in the RSI program at MIT under Dr. Moodera's supervision won the top award in Singapore National Science competition. Research resulted in nine publications and over ten invited talks at various national and international conferences, universities and laboratories. Dr. Moodera spent some time at Eindhoven Technical University as a visiting professor and was one of five US researchers invited to give a presentation and participate in a NSF panel discussion regarding the next ten years of research initiative. In addition, he was invited to write a feature article for Physics Today and received TDK Research Award once again in 2000 for his research in spin tunneling.

Dr. Harald Schwalbe's research includes the following:

- His research is focussed on the studies of structural and kinetic aspects of protein folding. He uses high resolution NMR spectroscopy as our primary tool. The random coil state of a protein consists of an ensemble of conformers. We have developed a model to predict the conformational averaging around the angles ϕ, ψ, and $\chi 1$ in the random coil state and could test this model from NMR measurements of chemical shifts, coupling constants and cross-correlated relaxation rates. In order to link the conformational analysis with the kinetics of folding, we are carrying out time-resolved NMR studies to gain insight into the structures of folding intermediates. This has been achieved by coupling the folding of proteins to the rapid release of ions from photo labile precursor molecules. The folding kinetics of single atoms could be determined. The accessibility of aromatic residues was further tested using Photo-CIDNP experiments. Single scan experiments could be performed that show the reorientation of the hydrophobic core of the protein during folding.
- A second focus is the characterization of structure and dynamics of RNA. His group was able to develop new NMR methods to determine all free torsion angles in RNA oligonucleotides including the backbone angles α and ζ which were considered inaccessible in the literature by exploiting cross-correlated relaxation in high resolution NMR. New research is now determining the geometry and energetics of Watson-Crick base pairs in solution. In the light of our new findings, Watson-Crick base pairs have to be described by a three state model, in which an intermediate is populated for 1%. In this intermediate, the nucleobases remain stacked but the hydrogen bonding interactions are weakened. Our new data allows the dissection of the energy contribution of hydrogen bonds and stacking to base pair stability.

FACILITIES

During the past year, FBML resources were consolidated into one building. We now boast an upgraded space for 2 750 MHz NMR magnets, as well as space for the wide bore 750 MHz magnet to be built under Dr. Yukikazu Iwasa.

Newly renovated facilities have recently been provided for Professor Cory's research group, including a wet lab and a computer lab.

Professors Keith Nelson and Andrei Tokmakoff of the Department of Chemistry have left the temporary lab space on the first floor used during completion of their permanent laser lab facility in the Chemistry Department.

Extensive renovation has been complete on the second floor to provide office space for Professor Jacquelyn Yanch, Professor David Cory and their students.

EDUCATION AND PERSONNEL

The Laboratory contributes to undergraduate education by participation in the Undergraduate Research Opportunities Program (UROP) a program that encourages and supports research-based intellectual collaborations of MIT undergraduates with Institute faculty and research staff. In addition, the laboratory has 20 full-time graduate and 8 postdoctoral students performing research.

FUTURE PLANS

Third magnet cell for a wide bore 700 MHz magnet is under renovation and requires completion.

During the past year 900 MHz instruments have been completed, and we have been told that NIH will issue a call for proposals to purchase these instruments early in 2001. We plan to submit such a proposal for a complete system

which will be part of the MIT-Harvard CMR. In connection with this proposal will be requesting that NW15 be renovated to accommodate two 900/1000 MHz NMR magnets.

In the longer term we also plan to complete construction of the second floor magnet hall, and instruments currently housed on the fourth and fifth floors will be relocated in order to create a comprehensive "Center for Magnetic Resonance." An alternative plan would be as Professor Schwalbe's research group grows, the space could house his instrumentation.

Robert G. Griffin

HAYSTACK OBSERVATORY

The Haystack Observatory, located in Westford, MA, is an interdisciplinary research center whose mission is to advance research and technical developments in radio science with applications to astronomy, geodesy, and atmospheric physics. The astronomy program emphasizes the use of radio interferometry for high-resolution imaging of galaxies and is carried out under the auspices of the Northeast Radio Observatory Corporation (NEROC), a consortium of eleven educational and research institutions in the northeast. An important component of the Observatory's mission is to support the training of students with particular emphasis on instrumentation technology and to provide opportunities for students to link their education with research. The Observatory receives financial support primarily from federal agencies including the National Science Foundation, the National Aeronautical and Space Administration, and the Department of Defense, as well as from industrial sources.

INSTRUMENTATION

The Haystack Observatory instrumentation consists of the following facilities:

- A 37-m diameter radio telescope used for astronomical observations and for radar measurements;
- An 18-m diameter radio telescope involved in geodetic measurements of the Earth's rotation parameters using very long baseline interferometry (VLBI);
- A VLBI correlator used to process global geodetic and astronomical observations;
- A high–power UHF radar that utilizes two large antennas, 46 m and 67 m in diameter, to study the Earth's upper atmosphere using incoherent backscatter techniques; and
- An optical observatory consisting of Fabry–Perot interferometers to measure winds in the Earth's upper atmosphere, and a lidar system at Firepond to measure temperature in the lower atmosphere.

RADIO ASTRONOMY

In astronomical research, Haystack Observatory concentrates on the application of Very Long Baseline Interferometry (VLBI) at millimeter wavelengths using an global array of radio telescopes to make high resolution observations of radio sources and study their structure and evolution. In the past year, Dr. Sheperd Doeleman and Dr. Colin Lonsdale have pursued a study of SiO masers in the Orion K-L region through measurements of the emission in various transitions of this molecule. They discovered numerous maser spots in the transitions that occur at 7 mm and 3 mm wavelengths and found a systematic spatial distribution of the spots relative to the central star, indicating the presence of an ambient temperature and density gradient in the circumstellar environment. Similar observations by Dr. Robert Phillips and collaborators of SiO masers in the shells of the supergiant stars R Cas and Mira reveal a nearly complete ring of maser spots with strong velocity structures and suggest the presence of turbulent or convective cells in the extended stellar atmosphere.

Other mm-VLBI projects include the study of the polarization of active galactic nuclei that provide information about the structure of the magnetic field in these synchrotron-emitting sources. In addition, the high angular resolution observations by mm-VLBI allows new outbursts feeding the radio jets of these galaxies to be probed near their point of origin. Calibration of the data has proven to be very challenging and the results have been found to be very sensitive to telescope calibration. To date, the radio source 3C273 has been found by Dr. Joanne Attridge to be unpolarized, and studies of source 3C279 reveal some polarization although a quantitative measure is not yet available.

Technical developments to explore VLBI observations at wavelengths shorter than 3 mm have continued with the development of a radiometer at 2-mm wavelength for the Heinrich Hertz radio telescope on Mt. Graham in Arizona. A hydrogen maser and a VLBI data acquisition system have been installed at the telescope and the first test experiment led by Dr. Sheperd Doeleman is planned for Fall 2000, using the Hertz telescope and the 12-m telescope on Kitt Peak. Maser emission from radio sources in our galaxy will be used as the primary emitters for the experiments. In preparation for the improvement of the VLBI sensitivity at these short wavelengths, development and tests of water vapor radiometers have continued by Dr. Alan Rogers and MIT graduate student David Tahmoush. Results to date indicate that the phase coherence has been extended by roughly a factor of two under relatively poor weather conditions.

In collaboration with Professor Jacqueline Hewitt, Physics Department, Haystack Observatory has continued its efforts to study the design of large radio-telescope arrays. Emphasis has been placed during the past year on the scientific and technical considerations for a low frequency array (called LOFAR) that covers the frequency range from

about 10 MHz to 220 MHz. This project is being pursued in collaboration with the Netherlands Foundation for Research in Astronomy and the Naval Research Laboratory. Under the leadership of Dr. Colin Lonsdale at Haystack, the various tradeoffs of array configuration, sensitivity and resolution have been conducted to optimize the scientific yield of the instrument. The scientific projects of interest to the MIT group involve measurements of the structure of the universe at the early epoch of reionization and the detection of transients such as gamma ray bursts and gravitational wave events through their radio emission. It is anticipated that the studies conducted to date will result in a funded project to construct the array, particularly since the project was endorsed recently by the National Academy of Sciences review of astrophysics and astronomy for the next decade.

GEODESY AND VLBI INSTRUMENTATION DEVELOPMENT

The VLBI Mk IV correlator system, designed at Haystack by a team led by Dr. Alan Whitney, has achieved operational status during the past year. Copies of the system have been successfully installed at the Haystack Observatory, the U.S. Naval Observatory in Washington, DC, the Max-Planck Institute in Bonn, Germany, the Joint Institute for VLBI in Europe in Dwingeloo, Netherlands, and the Smithsonian Sub-millimeter Array (SMA) atop Mauna Kea, Hawaii. The new system allows the processing of wide-bandwidth VLBI signals up to 1 Gbits/sec thus improving observational sensitivity. The new system also results in a substantial increase in the throughput of interferometric data processing for geodesy.

VLBI recording systems to support data acquisition at 1 Gbit/sec rates compatible with the Mk IV correlator system have focused in the past year on a design that utilizes commercial off-the-shelf components. Under the leadership of Dr. Whitney, a design and proof-of-concept phase has been started and a demonstration of the design approach is expected in the next year.

Tests of an E911 radio location system from cellular phones using CDMA digital phones have been successfully conducted under the leadership of Dr. Rogers, with support from TruePosition™. Current plans call for operational tests to be conducted in Manhattan in the next year to demonstrate the readiness of the system to meet the FCC requirements for cellular phone location in emergency situations.

ATMOSPHERIC SCIENCE

With the approach of the maximum in the solar cycle in 2001, the number of solar coronal mass ejections and ensuing geomagnetic storms have increased during the past year. This has provided excellent opportunities for the MIT incoherent scatter radars at Millstone Hill to observe the effects of disturbances in the Earth's ionosphere as a result of these storms. A novel correlation between ionospheric electric fields enhanced by the storms and coherent backscatter echoes has been detected by Drs. John Foster and Phil Erickson and will serve as an important diagnostic of ionospheric disturbances. Plans for coordinated global observations of geomagnetic storm effects in the Earth's lower thermosphere (90 to 150 km altitude) have been developed by Dr. Joseph Salah and Larisa Goncharenko, using a global array of incoherent scatter radars and the NASA TIMED satellite which will be launched in March 2001. Such measurements are expected to clarify the response of the Earth's upper atmosphere to geomagnetic storms at altitudes that have been hitherto unexplored by direct observations.

The most important accomplishment in the atmospheric sciences program at Haystack in the past year has been the successful implementation of a Rayleigh lidar technique using the Firepond 1.2-m optical telescope. Under the leadership of Dr. Thomas Duck, observations of lidar scatter have been recorded at altitudes from about 30 km to 100 km. Such measurements complement radar observations that extend from 100 km to 500 km and allow the study of wave propagation from the Earth's lower atmosphere into the upper atmosphere. The narrow field-of-view of the telescope has also allowed unprecedented daytime observations of density and temperature fluctuations to be made, thereby providing unique measurements of temperature inversion layers to be made. A systematic observational schedule has been developed to provide the database necessary to understand the causes of these inversion layers.

EDUCATIONAL PROGRAMS

A program to strengthen undergraduate education through research in radio astronomy has been successfully demonstrated during the past year using the MIT facilities at Haystack. Based on this success, support has been obtained from the NSF for an expanded program during the next three years. The program, led by Dr. Preethi Pratap, has involved 155 students from NEROC institutions and elsewhere as part of courses, laboratory exercises and special projects. Some projects have been conducted using the internet to access and control the 37-m telescope

remotely. Projects from MIT have involved Professor Leslie Rosenberg and his students in attempts to detect radio emission from axions.

Great interest has been expressed by various colleges and universities in a small radio telescope (SRT) kit developed at Haystack to allow students to enjoy a hands-on experience in radio observational techniques. A beta-version of the telescope with a 2-m antenna has been constructed using industrial involvement and is being shipped to 15 colleges and national astronomy centers for tests. This is a first step in the commercialization of this telescope so that colleges nationwide can acquire it for education. The SRT provides an excellent teaching tool for faculty and students prior to the use of the 37-m telescope for research projects. Examples of research projects that can be conducted with the SRT and the 37-m telescope have been provided on the Web, together with tutorials on radio astronomy.

Haystack Observatory has continued to host successful summer research internship programs for undergraduates and for pre-college science teachers, with support from the NSF. Nine students recruited from across the nation and three teachers recruited locally have participated in the program during the past year. The students and teachers are mentored by members of the Haystack staff and participate in the Observatory's research projects in astronomy, atmospheric science and instrumentation development.

Finally, Haystack was pleased to participate in the MIT artists-in-residence program which resulted in an exhibit in the Compton Gallery in Spring 2000 by Michael Wenyon and Susan Gamble. The exhibit of Haystack facility photographs was complemented by displays on the research and education programs underway at Haystack, thus providing an opportunity to communicate the Observatory's mission, instrumentation capabilities, and scientific results to MIT faculty, students and staff.

More information about the Haystack Observatory research and education programs can be found on the World Wide Web at http://www.haystack.mit.edu/.

Joseph E. Salah

MIT/WHOI JOINT PROGRAM IN OCEANOGRAPHY

The Joint Program of the Woods Hole Oceanographic Institution and the Massachusetts Institute of Technology offers advanced degrees in oceanography and applied ocean science and engineering. Graduate study encompasses virtually all of the basic sciences as they apply to the marine environment: physics, chemistry, geology, geophysics, and biology. Students who choose applied ocean science and engineering may concentrate in the major fields (civil, environmental, mechanical, and electrical), materials science, or oceanographic engineering. More than 160 scientists/faculty from the two institutions participate in the Joint Program. There are currently 111 students enrolled in the five areas of study offered in the Program: biological, chemical, and physical oceanography; marine geology and geophysics, and oceanographic engineering.

Since all the MIT faculty involved in the Joint Program are members of an academic department, their individual accomplishments and awards are reported through those departments. These include Courses I, II, VI, VII, XII and XIII.

The Report on the Response of the MIT/WHOI Joint Program to the Extenal Review Committee was submitted to Dr. Robert Gagosian and President Vest in November 1999, addressing the challenges set forth in the 1998 External Review of the Joint Program. Specific actions taken to strengthen the program included:

- More attention to preparation of faculty for teaching, advising, and mentoring;
- Enhanced career counseling, including more formal feedback and participation from alumni and alumnae of the Joint Program;
- Curriculum modifications to provide greater flexibility for physical oceanography students and revisions to the Student Guide for Applied Ocean Science and Engineering students.

The Response Report also reaffirmed the original Memorandum of Understanding between MIT and WHOI that established the Joint Program in 1968, and noted that high quality education in oceanography and ocean engineering may well be more important today than it was when the program began.

MIT officially joined CORE (Consortium for Oceanographic Research and Education), an organization of 61 member institutions who combine their efforts in order to help educate policymakers and the general public about the benefits of current and future oceanographic research.

WHOI held Commencement Exercises on June 3, 2000 for graduates of the Joint Program. Although commencement at MIT is an annual event, WHOI hosts a formal Commencement ceremony every ten years on the decadal anniversary of the founding of the Institution. Twenty-one recipients were on hand to receive the degrees of Master of Science, Ocean Engineer, Doctor of Philosophy and Doctor of Science. The formal ceremonies also recognized alumni/ae who have graduated since June 1990. Following Commencement, the MIT/WHOI Joint Program Alumni Association conducted a career seminar with current and former students.

More information about this Program can be found on the World Wide Web at http://web.mit.edu/mit-whoi/www/.

Paola Rizzoli, Ronni Schwartz

NUCLEAR REACTOR LABORATORY

During the past year the Nuclear Reactor Laboratory (NRL) continued its joint interdisciplinary activities with both MIT and non-MIT collaborators, including academic departments and interdepartmental laboratories and a number of other universities, schools, and nonprofit research institutions such as teaching hospitals. These joint research or teaching and training activities cover a wide spectrum in the life and physical sciences and in engineering, including development of cancer therapy, nuclear engineering, computer control of reactors, training in reactor operations, dose reduction and materials performance in power reactors, radiochemistry and trace analysis applied to the health effects from energy use, nutrition, earth and planetary sciences, environmental studies, and nuclear medicine.

There were two especially noteworthy developments during the past year. Both concerned the continued program in joint research with Beth Israel Deaconess Medical Center on the treatment of cancer utilizing the boron neutron capture method. The first was that construction and pre-operational testing of the fission converter facility was completed this year. This facility provides MIT with the best epithermal neutron beam for boron neutron capture therapy in the world. The second was the receipt from the U.S. Nuclear Regulatory Commission of approval for operation of the fission converter facility.

NEUTRON BEAM TUBE RESEARCH

The prompt gamma neutron activation analysis facility was used both for research and in support of the neutron capture therapy clinical trials.

ENVIRONMENTAL RESEARCH AND RADIOCHEMISTRY

Professor Frederick A. Frey, Department of Earth, Atmospheric and Planetary Sciences, and Dr. Pillalamarri Ila supervise operation of the Neutron Activation Analysis laboratory which is part of the Center for Geochemical Analysis within the Earth, Atmospheric and Planetary Sciences Department. Trace element abundances are determined in a wide range of natural materials. Currently the laboratory is focused on analyses of volcanic rocks recovered during the ongoing Hawaiian Scientific Drilling Project and the recently completed Leg 183 of the Ocean Drilling program which focused on sampling the very large igneous province that forms the Kerguelen Plateau.

Dr. Jacquelyn C. Yanch, Department of Nuclear Engineering, continued as head of the NRL's Trace Analysis Laboratory. She was joined by Dr. Pillalamarri Ila and together they continued to make the NRL's neutron activation analysis (NAA) facilities and expertise available to industry, other universities, private and governmental laboratories, and hospitals. Research and/or service-oriented collaborations were continued with several MIT research laboratories as well as with other educational and research institutions including: University of Miami, Harvard, California Institute of Technology, Tufts University, University of Utah, University of Connecticut, and University of Arizona.

Within MIT, research support has been provided to several departments. This research support includes analysis of various environmental and biological samples for trace and toxic metals for Professor William G. Thilly (Center for Environmental Health Sciences) as well as for faculty in both the Department of Civil and Environmental Engineering and the Department of Chemical Engineering.

A three–year collaborative grant to study the formation and emission of toxic substances from coal combustion continued with support from the U.S. Department of Energy. The ER&R facilities were used extensively in Course 12.119 Environmental Geochemistry.

A number of other research applications of NAA are summarized in a subsequent section, Reactor Irradiations for Research Groups outside MIT.

NUCLEAR MEDICINE

Clinical phase-I trials of boron neutron capture therapy (BNCT) for melanoma on the extremities were successfully performed up to the second dose level of 1250 RBE-cGy in the mid-1990s. Five irradiations were completed. No adverse reactions were observed on the subjects. However, three of the five lowest dose irradiations of deep-seated melanoma resulted in significant tumor regression. In one case a subject had two separate melanoma lesions irradiated at different times; four years later she is disease free in the irradiated areas. This trial remains open.

Phase-I studies of brain cancer, brain metastases of melanoma, and glioblastoma multiforme were performed from 1996–1999. Twenty-two volunteer subjects were irradiated, and the fifth dose level of 1420 RBE-cGy was reached. One serious adverse reaction was observed at one of the lower dose levels. It is unclear if this was because of the BNCT irradiation. Several of the brain tumor subjects experienced improved performance following the experimental BNCT irradiation. One intracranial melanoma showed essentially complete regression. This trial, which used the MITR's M67 epithermal beam, was successful in terms of the objectives of a Phase-I protocol. However, therapeutic dose levels were not reached. This trial is now closed. A new trial that uses the new fission converter beam that is described below is planned for 2001.

A fission converter based epithermal neutron beam irradiation facility for BNCT has been constructed over a period of 2.5 years and successfully put into operation during this year. The intensity of this beam has been measured and it is the highest intensity beam available anywhere in the world. The beam quality has also been experimentally verified and it is of near theoretical purity. When the electronic control system is completed this facility will be ready for irradiations of deep seated tumors, probably by early 2001. Irradiation times will be as short as a few minutes and therapeutic ratios (dose to tumor/dose to normal tissue) will be 4–5, a doubling over the therapeutic ratio available with the current MIT epithermal neutron beam.

This new facility will be the key component in future clinical tests of the efficacy of BNCT for cancer. It will also assure that MIT will maintain its leadership role in this research area.

A contract has been obtained from the US DOE for the reconstruction of the medical irradiation beam in the basement of the MITR. When completed this facility will provide a high intensity and high purity thermal neutron beam for BNCT irradiations of small animals and superficial human cancers.

BNCT research at the MIT Research Reactor is under the direction of Professor Otto K. Harling and is carried out in collaboration with the medical staff at the Beth Israel-Deaconess Medical Center. Six MIT graduate students are completing their theses on these projects.

RADIATION HEALTH PHYSICS

The NRL supports a subdiscipline in the Nuclear Engineering Department (NED), Radiation Health Physics, by providing relevant research opportunities. The NRL also contributes to a specially designed laboratory and demonstration course. This course, 22.09/22.104, Principles of Nuclear Radiation Measurement and Protection, is appropriate for all students in NED. Research topics and support for Health Physics students were provided by NRL projects, especially the BNCT and Dose Reduction projects of Professor Otto K. Harling.

Dr. John A. Bernard, who is certified as a Health Physicist by the American Board of Health Physics, continued to teach course 22.581, Introduction to Health Physics. This course uses the MIT Research Reactor to provide practical examples of health physics issues.

IN-CORE MATERIALS STUDIES

An experiment to study the shadow corrosion behavior of Zircaloy under prototypical boiling water reactor conditions through use of an in-core autoclave was successfully completed. Zircaloy specimens were exposed in-core and near-core in close proximity to a variety of other materials. This program was under the direction of Dr. Gordon Kohse and Professor Ronald Ballinger of the Nuclear Engineering Department and was funded by ABB Nuclear of Sweden.

A new in-core autoclave facility is now being built to study the effect of radiation on candidate ceramic clads. The benefit to the use of such clads is the elimination of the potential for a steam-zircaloy reaction that now exists with the zirconium-based clads that are currently in use. The program is funded by Gamma Engineering Corporation under a DOE Nuclear Engineering Research Initiative Grant.

REACTOR ENGINEERING

Dr. Bernard continued to teach course 22.921, Reactor Dynamics and Control, and to offer review classes on engineering fundamentals for NED students in the radiological sciences. Both activities make use of the reactor for illustrating theoretical concepts. The program on the digital control of nuclear reactors continued with thesis activity in the area of automated diagnostics.

MIT REACTOR RELICENSING AND REDESIGN

The relicensing of the MITR with a concomitant upgrade in power is in progress. It was previously identified that the MITR could operate at a maximum power of 6–7 MW with the existing heat removal equipment. A decision was subsequently made to submit the licensing documents for a power increase from 5 MW to 6 MW. On July 8, 1999 a formal application was submitted to the U.S. Nuclear Regulatory Commission (NRC) to relicense the reactor for an additional twenty years and to upgrade the power level to 6 MW. The relicensing package included a complete rewrite of the Safety Analysis Report and the Technical Specifications. The NRC has authorized the continued operation of the MITR pending its review of the application. That process remains ongoing. In conjunction with the relicensing effort, reactor systems are being upgraded. Both the internal and the environmental radiation monitors were replaced in 1998. The cooling tower and major portions of secondary piping were replaced in 1999. Upgrades to electrical distribution systems are planned for 2000.

REACTOR IRRADIATIONS FOR GROUPS OUTSIDE MIT

In nuclear medicine, the development and/or continuing production of radioisotopes for use by researchers at hospitals and other universities included investigations using track etching techniques by Dr. David Slaughter of the University of Utah to determine the uptake pattern of heavy metals by humans as well as the environment, and evaluation of copper and gold for arthritis treatments by Dr. Alan B. Packard of Children's Hospital.

In a number of other areas reactor irradiations and services were also performed for research groups outside MIT. Most of these represent continuations of previous research. Examples include Dr. Alan P. Fleer of Woods Hole Oceanographic Institute who used irradiation to determine natural actinides and plutonium in marine sediments and Dr. Rebecca Chamberlain of the Los Alamos National Laboratory who is investigating calibration of ultra-sensitive neutron monitoring devices by thermal neutron fission of uranium foils.

Whereas most of the outside users pay for irradiation services at the reactor, educational institutions needing such services for their own academic or research purposes are assisted in this regard by the USDOE through its "Reactor Sharing Program." A grant to MIT NRL reimburses us for the costs of providing irradiation services and facilities to other not-for-profit institutions (including teaching hospitals and middle and high schools). Under this program, 500 students and 50 faculty and staff from over 30 other educational institutions benefited from visits to and use of the MITR during the past year.

Research utilization of the MITR by other institutions under the Reactor Sharing Program during the past year has included: use by Professors J. Christopher Hepburn and Rudolph Hon of Boston College to activate geological specimens and standards for the NAA of rare earth and other trace elements in studies of the geological development of the northeastern United States; irradiation of air particulate samples for NAA by Professor Gerald Keeler of the University of Michigan; gamma irradiation of plant seeds for several area high school students participating in science fair projects; measurements of boron concentration and work on high resolution track etch autoradiography for Professor Robert Zamenhof of Beth Israel-Deaconess Medical Center; participation in several special high school student projects; neutron activation analysis of subsurface water supplies by Professor Jack Beal at Fairfield University; neutron time-of-flight and Bragg angle measurements by Professor Martin Posner's group at the University of Massachusetts; and use of gamma radiation by Dr. Mark Wimer of the Beth Israel/Deaconess Medical Center to sterilize artificial ligaments that are being evaluated in animal models.

For education of the general public and students at all levels in local and other New England schools, the reactor staff provides lectures and tours periodically throughout the year. One local university incorporated reactor visits and experiments into its regular course curricula, as follows: The University of Massachusetts, Harbor Campus, Professor Martin Posner, Department of Physics, Physics (Course #603).

MAJOR REACTOR SERVICES

A major project to neutron transmutation dope semiconductor grade silicon single crystals continued for a successful seventh year. Approximately 10 metric tons of Si crystals were accurately irradiated in shielded, automated irradiation facilities at the MITR. This project is under the technical direction of Professor Otto K. Harling.

AFFIRMATIVE ACTION

The NRL supports the affirmative action goals of the Massachusetts Institute of Technology. Of a staff of 36 there are currently five engineering and management positions held by minorities and women. The NRL participated in the

US DOE's program for minority training in reactor operations, and one of our current senior reactor operators is a graduate of this program.

MIT RESEARCH REACTOR

The MIT Reactor completed its 42nd year of operation, its 26th since the 1974–75 shutdown for upgrading and overhaul. The reactor operated continuously (seven days per week) to support major experiments. On average, the MIT Reactor was operated 95 hours per week at its design power level of 5 MW. Energy output for the MITR-II, as the upgraded reactor is now called, totaled 477,000 megawatt-hours as of June 30, 2000. The MITR-I generated 250,445 MW in the sixteen years from 1958 to 1974.

To summarize briefly the reactor was well utilized during the year, although still more experiments and irradiations can be accommodated because of the number and versatility of the many experimental facilities. The number of specimen irradiations was 300. There were 39 irradiations in the medical rooms, many in support of the neutron capture therapy program for the treatment of brain cancer and subcutaneous melanoma. Theses and publications on research supported by the reactor are running at about 15 and 30 per year, respectively. A total of 1031 people toured the MIT Research Reactor from July 1, 1999 through June 30, 2000.

More information about this department can be found on the World Wide Web at http://web.mit.edu/nrl/www/bnct.html.

John A. Bernard

OPERATIONS RESEARCH CENTER

The Operations Research Center (ORC), established in 1953 as a first-of-a-kind interdepartmental graduate degree program, completed its 47th year of operation in 1999–2000. The center administers its own graduate programs and a varied research program of methodological and applied projects. It maintains a reading room with a small library, as well as a contemporary computational environment of workstations and microcomputers.

This report summarizes the center's 1999–2000 activities and briefly reviews its educational, research and outreach programs.

FACULTY, STUDENTS, STAFF

Professor James B. Orlin, Edward Pennell Brooks Professor of Management Science and Cynthia Barnhart, Associate Professor of Civil and Environmental Engineering served as Codirectors during 1999–2000.

This year the ORC had 42 affiliated faculty and senior staff, with faculty drawn from the School of Management and the Departments of Electrical Engineering and Computer Science, Civil and Environmental Engineering, Ocean Engineering, Mathematics, Aeronautics and Astronautics, Mechanical Engineering, Nuclear Engineering, and Urban Studies and Planning.

The Operations Research Center offers two interdepartmental graduate degree programs, a Ph.D. and a master's degree. During 1999–2000, these programs enrolled 51 students—37 PhD candidates and 14 S.M. candidates. The Center conferred 8 master's degrees and 8 Ph.D.'s. Several other Ph.D. theses were in the final stages of completion in the summer of 2000.

ACADEMIC PROGRAMS

The ORC's academic programs continue to be recognized as ranking among the very best nationally and internationally. The program, moreover, is repeatedly cited as achieving an excellent balance between application and methodological domains.

Several affiliated faculty were active in significant educational development projects at MIT. Professor Larson heads up CAES. Professors Dimitris J. Bertsimas and Robert M. Freund collaborated in the curriculum development of the graduate program with Singapore in High-Performance Computation for Engineered Systems. The program offered its first subjects in fall of 1999.

RESEARCH ACTIVITIES

Research activities spanned a wide spectrum of methodological topics and applications, ranging from small, unsponsored projects involving a single faculty supervising a student's thesis, to much larger sponsored programs involving several faculty/staff and students.

Methodological research includes such topics as linear, nonlinear, and combinatorial optimization, solution methods for integer programming, interior point methods for linear and nonlinear programming; cluster analysis; parallel and distributed computation and algorithms; network flow algorithms; network design; probabilistic combinatorial optimization; deterministic and stochastic facility location; queueing theory, including queueing networks; risk analysis, stochastic processes; classical and Bayesian statistics; and decision analysis and statistical decision theory.

ORC faculty are also currently contributing to application domains as wide ranging as manufacturing, communications, transportation, public services, logistics, marketing, financial services, health care, and nuclear engineering. Current projects are addressing such topics as air traffic control, epidemiology, AIDS testing, life-cycle modeling of municipal solid waste, safety and risk analysis in air transportation, telecommunication network design, supply chain management, production scheduling, and transportation logistics.

Several organizations sponsored research projects at the ORC during 1999–2000, for example: the National Science Foundation; C.S. Draper Laboratory (several projects and Draper Fellowships); Computer Sciences Corporation; General Motors; Federal Aviation Administration's Center of Excellence for Aviation Operations Research; Logistics Management Institute; Office of Naval Research; Singapore/MIT Alliance Program; and the United Airlines.

OUTREACH AND PROFESSIONAL SERVICE

In its effort to serve the professional community at large, the ORC regularly undertakes a number of outreach activities.

Professor Amedeo R. Odoni offered a professional course during the 1999 summer session: "Airport Systems: Strategic Planning and Detailed Design."

The ORC Seminar Series was privileged to have many distinguished speakers from industry and academia this year. Among the many operations research professionals who made presentations were: Mitchell Burman (Analytics Inc.); Nitin Patel (Cytel Software); Egon Balas (Carnegie-Mellon); Adrian Lewis (U. of Waterloo); Gilbert Syswerda (i2 Tech); Anna Nagurney (U/Mass); Jan Van Mieghem (Northwestern); Yale Herer (Tel Aviv Univ); David Gamarnik (IBM); John Rust (Yale); Leonid Khachiyan (Rutgers); Edward Kaplan (Yale); Tom Cook (McKinsey and Co); Jim Dai (Georgia Inst of Tech); Tom Luo (McMaster Univ); Jaime Barcelo (Universitat Politecnica de Catalunya).

The center also offered a program of activities during the January independent activities period, including a series of presentations on the practice of operations research and management science presented by Bill Hall and Michael Ricard (Draper Labs); Les Servi (GTE); Ted Theodosopoulos (Bank Boston); Tim Kniker (Analytics, Inc.,) Hong Jin (i2 Technologies); Tsuneo Fujiwara (KPMG Peat Marwick LLP); Joseph Nemec (Booz Allen and Hamilton, Inc.) and Susan O'Dell (The Sabre Group).

The Operations Research Center conducted a Strategic Review during 1999-2000. We first began by establishing an internal strategic review committee. This committee consisted of the two ORC Codirectors and a selected number of ORC affiliated faculty members. The committee met regularly to discuss possible strategic directions for the ORC and to manage the review process. As part of our review, we conducted extensive surveys of ORC alumni, faculty and current students. We then held a one-day strategic retreat for ORC faculty, and other invited faculty. After the retreat, we held another one-day meeting in which we presented the findings of these efforts to an External Review Committee consisting of leaders in Operations Research, both from academia and industry. This Committee provided feedback and recommendations to the Codirectors for future directions. These recommendations will be incorporated into a strategic review of the ORC this coming academic year.

In 2000–2001, the focus will be on further evaluation (where needed) and implementation of recommendations from the strategic review process.

DIVERSITY

The ORC has always attempted to provide an environment that is responsive to the varied professional and personal needs of the OR community at MIT, and that builds upon diversity.

The ORC makes no faculty appointments. The staff of the ORC is composed of two support staff members and one administrative officer. Of these three staff, all are women, and one is African-American.

The center's graduate students are diverse, representing over 17 countries. In keeping with the center's tradition of seeking and attracting outstanding women, the number of female students has historically averaged about 30%. Currently, the percentage of women is below our historical average. One of the past priorities of the ORC was to recruit more outstanding women graduate students. We were quite successful in this task during this year's admission's pool. We made an offer of admission to five women candidates of which four accepted our offer.

PROFESSIONAL ACTIVITIES

The ORC-affiliated faculty and students continue to assume positions of leadership and receive many awards within the Operations Research and Management Science community. Cynthia Barnhart, Andrew Armacost, and Keith Ware (United Parcel Service) were awarded Best Overall Presentation at the 39th Annual Symposium of the Airline Group of the International Federation of Operations Research Societies (AGIFORS). Their paper was entitled, "Planning Models for Designing Express Shipment Service Networks." Arnold Barnett presented the Omega Rho Distinguished Lecture at the INFORMS Conference in Philadelphia. Professor Barnett was also the 1999 honorary inductee into Omega Rho for his contributions to Operations Research/Management Science. Arnold Barnett received a teaching excellence award from the Sloan School, for the third year in a row, and his ninth award in total.

(Five of these awards have been for Teacher of the Year.) Robert Freund was named Teacher of the Year at the MIT Sloan School of Management. Rob was also the recipient of the Class of 1960 Innovation in Education Award this year. Michel Goemans received an IBM Faculty Partnership Award. Gordon Kaufman was elected Fellow of the American Association for the Advancement of Science. Dick Larson gave an invited testimony before the U.S. House of Representatives. Andrew Lo was the recipient of the 1999 Graham and Dodd Award. Tom Magnanti was elected a Fellow of the American Academy of Arts and Sciences. Also, Tom was the IFORS Distinguished Lecturer at the Salt Lake City INFORMS Meeting. Sanjoy Mitter is the recipient of the IEEE 2000 Control Systems Award. This is the major award in the field of Systems and Control. Andreas Schulz was elected by the Berlin-Brandenburg Academy of Sciences and Humanities and the Academy of Natural Scientists Leopoldina as Founding Member of The Young Academy of Science. Also, Andreas was the recipient of a General Motors Innovation Grant. Larry Wein was elected as Editor-in-Chief of Operations Research. Marina Epelman, an ORC alumna, received Second Prize in the INFORMS Nicholson Student Paper Competition for 1999–2000, for research conducted as part of her dissertation at the ORC. William Hall, an ORC alum, received Honorable Mention in the INFORMS 1999 George Dantzig Dissertation Award. Bill's dissertation also received the INFORMS Transportation Science Section Award.

More information about the Operations Research Center can be found on the World Wide Web at http://web.mit.edu/orc/www/.

Cynthia Barnhart, James Orlin

PLASMA SCIENCE AND FUSION CENTER

The Plasma Science and Fusion Center (PSFC) is recognized internationally as a leading laboratory in developing the scientific and engineering aspects of magnetic confinement fusion and conducting cutting-edge research in plasma science and related technology. Research at the PSFC is carried out in 5 primary areas:

- Fusion energy confinement research in the Alcator C-Mod tokamak, including investigations of the stability, heating, and transport properties of high temperature magnetically confined plasmas, as well as advanced tokamak research (AT);
- Investigation of the basic physics of plasmas including magnetic reconnection experiments on the VTF facility, new confinement concepts such as the Levitated Dipole Experiment (LDX), development of novel high-temperature plasma diagnostics, novel diagnostic of inertial fusion experiments, basic laboratory and ionospheric plasma physics experiments, and theoretical research;
- A broad program in fusion technology and engineering development that addresses problems in several areas (e.g., magnetic systems, superconducting materials, fusion environmental and safety studies, and system studies of fusion reactors);
- A significant activity in developing environmental remediation techniques based on plasma technology, including industrial applications; and
- The physics of waves and beams (gyrotron and high gradient accelerator research, beam theory development, non-neutral plasmas, and coherent wave generation).

The Plasma Science and Fusion Center Research and Development programs are supported principally by the Department of Energy's Office of Fusion Energy Sciences. There are approximately 247 personnel associated with PSFC research activities. These include: 16 faculty and senior academic staff, 49 graduate students and 4 undergraduates, with participating faculty and students from Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Physics; 67 research scientists, engineers and technical staff, 59 visiting scientists and engineers, postdoctoral associates and research affiliates, 29 technical support personnel; and 23 administrative and support staff.

PSFC's funding decreased in fiscal year 2000 by about 18% over fiscal year 1999 from $31.5 million in fiscal year 1999 to $25.9 million. This decrease had been anticipated with the completion of the DOE-funded ITER Program. For fiscal year 21001 we expect flat (or slightly decreased) funding, depending on the outcome of the final congressional budget for DOE.

ALCATOR DIVISION

The Alcator Division, led by Prof. Ian Hutchinson and deputy division head Dr. Earl Marmar, carries out experimental research on Alcator C-Mod, a compact, high field high-performance divertor tokamak devoted to investigating the physics of high temperature magnetically confined fusion grade plasmas. The total staff of the Alcator Project is about 100, including 18 full time physicists, four faculty members and 18 graduate students. Recently, C-Mod has become a National User's Facility, and as such, the total C-Mod project funding is supplemented by approximately 20% by way of non-MIT collaborators. Substantial ongoing collaborations with the University of Texas, Austin and the Princeton Plasma Physics Laboratory, are making major contributions to all areas of the C-Mod research effort. Direct funding to MIT grew to $15.2 million in fiscal year 2000 (an increase of $0.8 million) as a consequence of having obtained approval of the 3 year, $4.2 million new lower-hybrid upgrade to C-Mod. Funding for the upgrade is to be shared with the Princeton Plasma Physics Laboratory.

There are four areas of investigation on Alcator C-Mod. Transport studies on C-Mod provide critical tests of empirical scalings and theoretically-based interpretations of tokamak transport at unique dimensional parameters, but with dimensionless parameters comparable to those in larger experiments. Plasma boundary research on C-Mod takes advantage of the advanced divertor shaping, very high scrape-off layer power density, high divertor plasma density, unique abilities in diagnosis and neutral control, and a high-Z metal wall. Ion cyclotron radio frequency power provides the auxiliary heating on C-Mod, and is exploited not only for research into wave absorption and heating processes but also for profile control via mode conversion processes and associated current drive mechanisms. Advanced tokamak research in the future on C-Mod proposes to demonstrate fully relaxed current profile control and sustainment through efficient off-axis current drive by radio waves in the lower hybrid range of frequencies.

Plasma transport is dominated by turbulence under most conditions but often radially-localized regions of reduced transport, "transport barriers" occur. In these regions turbulence is suppressed and steep density or temperature gradients occur together with strong radial electric fields. These barriers are of intrinsic scientific interest but also great importance as a method of improving confinement. Alcator C-Mod has implemented measurements of unprecedented spatial resolution of the H-mode barrier which constitutes the sharp edge of the plasma. We have also begun studies of internal barriers induced by a variety of techniques.

Plasma rotation is an important ingredient of the transport problem both because it reveals important basic information about transport processes and because it is believed to cause the turbulence suppression in transport barriers. C-Mod's unique role in rotation studies is that it has no internal momentum sources and so presents a 'pristine' transport test-bed for momentum transport.

Divertor studies using C-Mod's dynamic gas bypass control have led to a new view of the processes determining the level of neutral pressure in the divertor chamber; namely that it adjusts itself to keep the bypass throughput approximately constant. This observation is important for planning future divertor pumping and closure. Edge studies are increasingly focusing on understanding how the plasma behavior varies from the closed to the open magnetic flux surfaces, in other words the transition across the separatrix.

Ion cyclotron radio frequency (ICRF) power on C-Mod was almost doubled to the 7 MW level through the addition of 4 MW of tunable power in the 40-80 MHz range and a four strap antenna (a collaboration with Princeton Plasma Physics Laboratory). These major upgrades will make it possible to explore rf wave absorption and tokamak confinement physics near the ideal MHD beta-limit. Mode conversion from fast Alfven waves to short wavelength Bernstein waves are also being explored and mode conversion current drive experiments will be performed using the new phaseable four strap antenna built at Princeton. Detailed comparisons between ICRF theory and experiment are being carried out using a state of the art full wave electromagnetic field solver (the TORIC code) that was implemented at MIT through a collaboration with the Max Planck Institute for Plasma Physics (Germany).

This past year we received approval from DOE for the addition of a new RF system to C-Mod, namely, a 3 MW, 4.6 GHz lower-hybrid microwave system. The addition of 3 MW of off-axis lower hybrid current drive power will make it possible to operate the tokamak near the ideal MHD beta limit at somewhat reduced fields with purely noninductively maintained current profiles. A significant fraction (60–70%) of the total current in these discharges will be generated by "bootstrap" effects and the auxiliary heating will be supplied by 5 MW of ICRF heating power at 80 MH and 60 MHz. The ultimate goal of these experiments is to demonstrate control of the current profile and sustainment of high MHD beta limits in the presence of steep transport barriers and fully related current profiles. A detailed theoretical modeling program has been carried out for several years, and its results have clearly shown C-Mod's excellent potential to carry out these "Advanced Tokamak" types of experiments. This program will ensure a vigorous research program on Alcator for at least the next 5 years.

PHYSICS RESEARCH DIVISION

The Physics Research Division, headed by Professor Miklos Porkolab, seeks to develop a theoretical and experimental understanding of plasma physics and fusion science. This division is also a base for developing basic plasma physics experiments, new confinement concepts, novel inertial confinement fusion diagnostics and space plasma physics experiments. In addition, this division is also the home for a strong base and supporting theory program.

Fusion Theory And Computations

Plasma Edge And Core Transport And Turbulence Theory

The Plasma Edge and Core Transport and Turbulence Theory Group (Drs. Dieter Sigmar and Peter Catto, and visiting scientist Jim Hastie) goals are to understand plasma and neutral particle turbulence, transport, and stability effects in plasma science experiments. The research relies on analytic and numerical investigations, as well as experimental observations from Alcator C-Mod and other tokamaks; and includes theoretical support for the Levitated Dipole Experiment (LDX) being built at the PSFC in collaboration with Columbia University. The two most significant results of our research during the past year are a demonstration that wave driven parallel current can be generated in a tokamak in the absence of parallel momentum input via wave-particle interactions if collisions are retained; and proof that the finite plasma pressure equilibrium confined by a point dipole magnetic field is magnetohydrodynamically stable as long as the pressure is nearly isotropic.

Advanced Tokamak Physics, Mhd Stability, And Rf Interactions

In this research area, state of the art simulation codes have been developed (Drs. Paul Bonoli and Jesus Ramos and Prof. Miklos Porkolab) and used to compute self-consistent MHD equilibria in the presence of non-inductively driven currents. These studies form the basis of a proposed major upgrade to the Alcator C-Mod tokamak involving the addition of off-axis lower hybrid current drive power (up to 3 MW) and 5 MW of ion cyclotron resonance heating power. This will allow C-Mod to explore stable modes of operation near the ideal MHD beta limit. These so-called advanced tokamak operating modes are characterized by enhanced confinement regimes, high fractions (approximately 70%) of non-inductive "bootstrap current" (self generated toroidal currents by finite plasma pressure), and non-monotonic current profiles. The most recent efforts have concentrated on modeling pressure and current profiles that are expected to arise as a result of transport barriers.

A significant new research result achieved in this area during the past year was the simulation of mode converted ion Bernstein waves (IBW) in toroidal geometry using a full-wave ICRF electromagnetic field solver. This code was developed at the Max Planck Institut fur Plasmaphysik in Garching by Dr. Marco Brambilla and was implemented at MIT by Dr. Paul Bonoli through a collaboration. Model predictions for electron heating by these mode converted waves were found to be in close agreement with experimental data from the Alcator C-Mod tokamak. Computations of this type push non-parallel supercomputing technology to its limit in terms of code memory requirements. However efforts are now underway to implement the field solver on a massively parallel platform (MPP).

Rf Heating And Current Drive Theory And Basic Plasma Theory

Under the leadership of Prof. Abraham Bers and Dr. Abhay K. Ram, theoretical and computational work has resulted in a number of accomplishments. A study of RF current drive in the presence of bootstrap current—of importance to the steady-state operation of tokamak fusion reactors—has been completed and submitted as the Ph.D. thesis of Mr. Steven D. Schultz. At high fractions of bootstrap current, a synergism between bootstrap current and RF current drive is found to be significant. A new study has been initiated to evaluate the emission from electron Bernstein waves as a means for measuring the electron temperature in high-beta plasmas such as the National Spherical Tokamak Experiment (NSTX). Experiments addressing this are being carried out by the members of the NSTX team at the Princeton Plasma Physics Laboratory.

Computational model studies have been carried out to explain the observed effects of ion-acoustic wave damping on the saturation of stimulated Raman scattering (SRS) in intense laser-plasma interactions. Reducing light reflectivity due to SRS is of crucial importance to the success of efficient inertial fusion energy generation with lasers. Studies have also been initiated on laser-plasma interactions in a single hot spot in collaboration with the Los Alamos National Laboratory (LANL) experiments on TRIDENT. A graduate student will participate in these experiments at LANL. Finally, studies on nonlinear energization and de-energization of plasma ions by multiple waves in a magnetic field has received new funding by a joint NSF-DOE basic plasma studies program.

Plasma Physics Experiments

Levitated Dipole Experiment

The Levitated Dipole Experiment (LDX) represents a new concept exploration experiment funded by the Department of Energy. LDX is a joint collaborative project with Columbia University and it will be located in NW21 at MIT. The principal investigators of this project are Dr. Jay Kesner of the MIT and Professor Michael Mauel of Columbia University. The LDX facility is being designed by the engineering division of the PSFC under the leadership of Dr. J. Minervini. The project has been funded as a 5 year grant, with a budget of $1.5 Million for fiscal year 2000 (shared between MIT and Columbia University). The construction of the project will take place during the initial 3 1/2 year period and a substantial fraction of the fiscal year 1998–fiscal year 2000 budget will go toward the design and fabrication of the facility.

The levitated dipole experiment represents a new and innovative approach to magnetic fusion which will utilize a levitated superconducting coil to confine plasma in a dipole magnetic field. The concept was inspired by observations that high pressure plasmas can be confined by planetary dipole magnetic fields, such as the magnetosphere which surrounds Jupiter. Compared with the traditional fusion approaches the levitated dipole may permit the confinement of higher pressure plasmas with reduced cross-field transport.

The design of the facility was largely completed during fiscal year 1998 and we are now in the construction phase. The vacuum chamber is in place in the Tara cell of NW21 and the high performance Nb3Sn coil has been

successfully tested. The first plasma results are expected in the summer of 2001. When completed LDX will be the only superconducting magnetic confinement experiment in the U.S. fusion research program.

Magnetic Reconnection Experiments On The Versatile Toroidal Facility (Vtf)

The basic experimental plasma physics group, led by Prof. A.Fasoli, is concentrating its efforts on the general issue of magnetic reconnection, i.e. the link between the plasma dynamics and changes in the magnetic field structure. Reconnection determines the sun corona heating (solar flares), the interaction between the solar wind and the earth magnetic field (aurora) and, in fusion devices, fast relaxation processes that can influence dramatically the plasma confinement. The construction of the apparatus to study magnetic reconnection has been completed, mostly using pre-existing facilities at the MIT-PSFC. Collisionless plasmas of interest for magnetic reconnection studies are now routinely produced in the Versatile Toroidal Facility, VTF, by electron cyclotron resonance heating. Reconnection is driven by applying a toroidal electric field perpendicular to the poloidal magnetic cusp field, thereby producing a radial plasma drift into the magnetic null point. The link between the change in magnetic topology and the particle dynamics is studied by combining measurements of particle flow velocities and distribution functions with those of the evolution of the magnetic field structure and of plasma fluctuations. The diagnostic systems to perform these investigations are being installed mainly with the help of a post-doctoral fellow and students.

Professor Fasoli has recently been selected for the Junior Faculty Development Award by the DoE's Office of Fusion Science, with funding starting this fall at a level of about $170,000 per year for three years.

PSFC/Joint European Tours (JET)

Collaboration On Alfvén Wave Instabilities

The collaboration with the world's largest magnetic confinement device, the Joint European Torus, at Oxford (UK), conducted by Prof. A.Fasoli and "on-site" post-doctoral fellow Dr. Ducio Testa, continues to produce new experimental results on the physics of plasmas close to fusion reactor conditions. The issue of the stability of Alfven waves in the presence of fusion produced 3.5 MeV alpha (α) particles was studied. A new mechanism for the stabilization of the α-driven instabilities was discovered by comparing the measured damping rates of externally excited Alfven modes with the results of numerical simulations based on the plasma kinetic model. This mechanism is based upon mode conversion of the global Alfvén waves into locally absorbed kinetic modes. Fundamental nonlinear wave-particle physics was also explored at JET. We observed for the first time the strongly nonlinear regimes predicted by the general theory of near-threshold kinetic instabilities, with chaotic and explosive behavior for both waves and particles. The extension of the external wave driving technique to low frequency magnetohydrodynamic modes led to a method to diagnose the plasma proximity to instability limits, to be used in real-time to control the plasma so as to avoid macroscopic instabilities leading to major disruptive events. The implementation of this technique on the two largest US tokamaks, DIII-D at General Atomics and Alcator C-Mod at MIT, is now being explored.

Inertial Confinement Fusion Experiments

MIT's effort in inertial confinement fusion, led by Dr. Richard Petrasso and co-workers, has continued to produce exciting results on experiments conducted at the OMEGA laser facility at the Laboratory for Laser Energetics at the University of Rochester. MIT has been responsible for designing and implementing two very large charged-particle spectrometers. This work is a collaboration with the University of Rochester and Lawrence Livermore National Laboratory.

In order to understand the dynamics of the implosion process, the spectrometers are used to detect charged fusion products that are generated at the core of the imploding capsules. From the number of such reactants (i.e. the yield), the effectiveness of the fusion process can be determined. And from the energy loss of the reactants, as they pass through the capsule, a measure of the plasma containment can be determined. Both these quantities, yield and plasma containment, are fundamental parameters needed to characterize the quality of the implosions. In addition, since the spectrometers view the implosion from nearly 90 degrees apart, the implosion symmetry can be sensitively studied.

These spectrometers are prototypes for those being designed by MIT and collaborators for the National Ignition Facility (NIF) at Lawrence Livermore. In concert to these plans at the NIF, MIT organized and led the Basic Science Users Group for the NIF. This was a three-day workshop, held in Pleasanton, California, with 175 participants from the US, Japan, France, Germany, Canada and Japan. Extensive discussions and presentations were made on those

areas of fundamental science—astrophysics, materials science, hydrodynamics, radiative sources and properties, plasma physics—that can be addressed at the NIF. For example, at the core of NIF implosions, we expect to achieve plasma densities that are 6 times larger than the density at the center of the Sun, or 52 times more dense than gold.

Novel Diagnostics For Magnetic Fusion Research

The development of fusion energy diagnostic technology is an ongoing effort at the PSFC. In one initiative, PSFC and General Atomics (GA) have collaborated for several years now on Phase Contrast Imaging (PCI) on the DIII-D tokamak at GA. Presently the experiments are being carried out by an MIT post-doctoral associate, Dr. Chris Rost on site at General Atomics. Through careful study over time, properties of edge turbulence in plasmas are being mapped out. The goal is to better understand improved plasma confinement regimes through a reduction (or elimination) of edge plasma turbulence. In another area, gyrotron scattering experiments (Dr. Paul Woskov and coworkers) have been completed on JET. Results obtained on JET verified the viability of this technique to detect the distribution function of energetic ion tails in the presence of intense RF heating. A new project has been initiated last year by way of a new 3-way collaboration among U.S., Dutch, and German scientists on the TEXTOR tokamak in Jülich, Germany. Continuation of this experiment is expected for the foreseeable future.

Ionospheric Plasma Research

Visiting Professor Min-Chang Lee and his students successfully tested PSFC's portable HF/VHF radar at Millstone Hill, Massachusetts during June 12–July 21, 2000, with frequency licenses issued by the federal government. Recently space plasma experiments in Massachusetts, Alaska and Puerto Rico have been scheduled for this group, aimed at the study of plasma turbulence which occurs naturally, or as the consequence of injected radio wave-plasma interactions in space. PSFC's Ionospheric Radar Integrated System (IRIS), including the portable radar, a digital ionosonde, and two student-built VLF receiving systems will be used for ground-based space plasma diagnostics. The radar transmitters, operating in the frequency range of 10–60 MHz, will provide new rf sources for Professor Lee's group to conduct laboratory simulation experiments, using PSFC's Versatile Toroidal Facility (VTF). These field and laboratory experiments will improve the understanding of space plasma turbulence/space weather and enhance radio communication capabilities.

WAVES AND BEAMS DIVISION

The Waves and Beams Division, headed by Dr. Richard Temkin, conducts research on novel sources of electromagnetic radiation and on the generation and acceleration of particle beams. Besides the able assistance of Principal Research Scientist Dr. Ken Kreischer, this Division has a very substantial graduate student involvement in its research program.

Gyrotron Research

The gyrotron is a novel source of microwave, millimeter wave and submillimeter wave radiation. Gyrotrons are under development for electron cyclotron heating (ECH) of plasmas in magnetically confined fusion experiments, as well as for high frequency radar. These applications require tubes operating at frequencies in the range 90-300 GHz at power levels of up to several megawatts. Dr. Kenneth Kreischer leads the gyrotron research group. In CY2000, we have completed the design of a new gyrotron oscillator intended to operate at the 1 to 1.5 MW power level. When operated at the 1 MW power level, it will provide additional margin (50%) in safety and reliability for the gyrotron. Reliability of gyrotrons and related equipment was identified by the fusion community as a major issue in electron cyclotron technology development. The new gyrotron will be tested at both MIT and at an industrial vendor, Communications and Power Industries of Palo Alto, CA. The MIT device will operate in 3 ms pulse lengths while the industrial tube should be capable of continuous wave (CW) operation. Research challenges include operation of the gyrotron in stable, single-mode oscillation without mode competition; production of a high quality electron beam; achievement of high interaction efficiency in the resonator and achievement of very high overall efficiency (>50%) when operated with a depressed collector. Experiments will begin at MIT in 2001 and in industry in 2001 or 2002.

In gyrotron research, it is also critical to have a high efficiency mode converter that can transform the output mode of the gyrotron into a Gaussian beam in free space. In recent years, we have been studying the measurement of the phase distribution in microwave beams using a phase retrieval algorithm based on the measure field amplitude on a series of planes. In 2000, a new approach has been explored to determine the phase distribution in the beam. This method uses the measured field amplitude on a series of planes but relies on calculated moments of the field amplitude to determine the parameters of a polynomial expansion of the spatial phase distribution. The method will

be applied to design single mirror correctors for the gyrotrons at General Atomics in San Diego. A new idea for a gyrotron microwave window, a dome shaped window, is also under investigation. This research is primarily sponsored by MIT Lincoln Lab through their Advanced Concepts Committee (ACC) internal funding program. Dynamic tests of this window, at high pressure and temperature, have begun in 2000, following a successful static pressure test. Full test results are expected this year.

In research on a 250 GHz gyrotron for use in electron spin resonance and nuclear magnetic resonance studies, reliable operation for many hours was achieved this year with operation at CW power levels of up to 25 W and pulsed power levels of up to 100 W. This research, funded by NIH in collaboration with Prof. R. Griffin of the Magnet Lab, is a pioneering effort in high frequency electron spin resonance studies. Signal enhancements of sixty have been demonstrated in initial NMR experiments. Future work at 500 GHz is under analysis. In a new program which started last year, we have been funded as part of a DOD MURI consortium for Innovative Vacuum Electronics. We have begun research on a gyrotron amplifier at 95 GHz; photonic bandgap structures and novel cathodes. The 95 GHz amplifier is being constructed with first tests planned at 140 GHz using available equipment. A gyrotron amplifier with a confocal waveguide structure has been built and will be tested in the summer of 2000.

High Gradient Accelerator

The High Gradient Accelerator Group is conducting research on a novel, 17 GHz, microwave driven, photocathode electron injector. This device, sometimes called an RF gun, can generate a 2 ps beam of 1-2 MeV, 50-500 A electrons at high repetition rate. A 26 MW, 17.1 GHz klystron power source drives the electron gun. The electron beam can be directly applied to microwave generation experiments or it can be used as an injector into a 17 GHz, high gradient accelerator. This research supports the program to build new electron accelerators that can reach the TeV range of energies. In 2000, the RF photocathode electron gun has been rebuilt with magnetic solenoidal focusing to achieve higher electron beam brightness. A new microwave power distribution system has also been installed to allow power to be sent to either the RF gun or the Haimson accelerator. The emittance of the electron beam has been measured to be 3 p mm mrad for a 50 pC electron bunch, close to a record high value of beam brightness. A new electron gun that can achieve higher electron beam energies, over 2 MeV, and higher beam quality has been designed and is being fabricated. The Haimson 17 GHz electron accelerator achieved first operation in CY2000 with a 17 MeV electron beam. This is the highest power accelerator on the MIT campus and the highest frequency stand-alone accelerator in the world. One potential application of this accelerator is in free electron laser research. Improvements to the 17.1 GHz klystron have been made in 2000 to secure reliable operation at power levels of at least 15 MW at 17.14 GHz. A photonic bandgap cavity has been built and tested for operation at 17 GHz. This novel structure may have advantages over conventional microwave structures. This research program should establish 17 GHz as a feasible frequency for future TeV electron colliders.

Theoretical Research In Beams And Non-Neutral Plasmas

The Intense Beam Theoretical Research Group, led by Dr. Chiping Chen, has contributed very significantly to our understanding of coherent radiation generation and particle acceleration. Topics covered include coherent radiation sources (CARM, FEL, gyrotron, relativistic klystron, relativistic TWT), intense beam transport and beam halo formation, beam-beam interactions, cyclotron resonance accelerators, two-beam accelerators, photocathode design, and related topics. Research explores self-field-induced nonlinear resonant and chaotic phenomena in intense charged particle beams. This research supports the U. S. program to construct advanced accelerators for such applications as nuclear waste treatment, heavy ion fusion and free electron lasers. In 2000, a new Green's function code was written and was applied to studies of self-fields in bunched electron beams. One result of this new theoretical work is a general prediction of the limiting beam current that can be transported in microwave devices including klystrons and traveling wave tubes. In collaboration with Ron Davidson and his research group at Princeton, a technique has been developed for ideal matching of heavy ion beams.

PLASMA TECHNOLOGY DIVISION

The objectives of the Plasma Technology Division, led by Drs. Daniel Cohn and Paul Woskov, are to develop new fusion spin-off applications, particularly in the environmental area; to develop new fusion diagnostics; and to develop new fusion reactor system concepts. A major thrust is in the area of plasma aided manufacturing of hydrogen. Hydrogen has potential environmental advantages as a fuel that can greatly reduce pollution from stationary electricity generating systems and from vehicles. There are two projects. One project investigates the use of plasmatron devices for manufacturing hydrogen for use in stationery fuel cell facilities, vehicle refueling stations and hydrogen production facilities. The other project is investigating the vehicular use of compact plasma boosted

devices for onboard conversion of hydrocarbon fuels into hydrogen-rich gas. The hydrogen-rich gas would then be combusted in a conventional spark ignition engine. Using the hydrogen-rich gas as an additive to gasoline, large reductions in NOx, a major air pollutant, can be obtained. Onboard hydrogen from plasma boosted devices production can also be used in catalytic reduction of diesel engine exhaust. Plasma boosted fuel conversion technology could greatly reduce pollution from cars, trucks and buses in the relatively near term without substantial cost increases or inconvenience. Over the longer term, the technology could facilitate the use of difficult to use alternative fuels; one possibility is the use of greenhouse gas reducing bio-oils that could be produced from rapidly growing trees and crops. Future plans include an expanded program in collaboration with Professor John Heywood of the Mechanical Engineering department and the Sloan automotive laboratory. The Plasma Technology Division is also investigating the use of millimeter wave reflectometry and pyrometry for measurement of the properties of glass produced in vitrification of radioactive waste.

TECHNOLOGY AND ENGINEERING DIVISION

The Technology and Engineering (T&E) headed by Drs. Joseph Minervini and Richard Thome conducts research on conventional and superconducting magnets for fusion devices and other large-scale power and energy systems.

During the past year the major emphasis of the Division's effort has been on testing the Central Solenoid Model Coil (CSMC) which was built as one of the major R&D tasks of the ITER Engineering Design Activity (EDA). During the past year, the Inner Module of the CSMC, developed in the US, was installed with the Outer Module, developed in Japan, at a special, large-scale test facility located at the Japanese Atomic Energy Research Institute (JAERI) in Naka, Japan. With strong on-site participation by T&E Division engineers, the coil was successfully tested to design operating conditions and beyond, both in steady state and pulsed operation. Daily electronic transfer of test data from the remote test site allows detailed analysis by Division staff at MIT. The CSMC is the world's most powerful superconducting pulse magnet, storing 640 MJ of energy at the design field of 13T. It is also the world's largest superconducting magnet using Nb3Sn superconductor. The successful operation of this magnet is an important milestone in the development of large-scale superconductors and has potential benefit for magnet and power applications beyond fusion.

Significant progress was achieved in development of the magnet systems for the Levitated Dipole Experiment (LDX). Fabrication of the Floating Coil (F-Coil) was completed and the coil was successfully tested in July 2000. This innovative coil uses state-of-art Nb3Sn wire in a novel cable-in-channel conductor design. The coil itself incorporates a unique method for internal quench protection by use of co-wound copper eddy-current heaters. The completely potted construction gives inherent structural integrity. Preliminary test results indicate the coil is highly stable with no signs of training and no quenching to 110% of rated current. This result was achieved even when ramped up at 10x the rated ramp rate. Major progress was also achieved in fabrication of the F-coil cryostat and the charging station. A sub-contract for the Charging Coil (C-Coil) was placed with the D.V. Efremov Scientific Research Institute of Electrophysical Apparatus in St. Petersburg, Russia. Division staff are responsible for monitoring and approving the design.

Collaboration with the American Superconductor Corporation continued under a Phase II SBIR, for development of high temperature superconductors (HTS) for fusion applications and for the design of an HTS levitation coil (L-Coil) for the Levitated Dipole Experiment at MIT. During the next year, MIT will complete the design of the L-coil, have it constructed and install it in the LDX facility. This will be the first application of HTS magnet technology to the US Fusion program.

The Division is providing engineering support to the Princeton Plasma Physics Laboratory in the evaluation of Next Step Options for the US Fusion Program and in the design of selected machines, specifically, the Fusion Ignition Research Experiment (FIRE). In this regard, the lead for the program and the physics assessment is based in Princeton and Dr. Thome leads the engineering effort from MIT. The Division provides a major role in the magnet system design, cryogenic system design, and structural design for the FIRE as well as systems level studies.

Other major Division activities included continuation of materials development on the new superalloy Incoloy Alloy 908 in the Materials Laboratory of the Technology and Engineering Division under the leadership of Prof. Ronald Ballinger. Another active area of research was performed under sub-contract to the Samsung Advanced Institute of Technology for magnets and magnet systems design for the Korean K-STAR superconducting tokamak program. The Division continued to play an important role in technology development of magnet systems and quadrupole

magnet array design studies for the Lawrence Berkeley National Laboratory in support of the High Current Transport Experiment (HCX) and the Integrated Research Experiment, (IRE) which are the main elements of the US Heavy Ion Fusion Driver program, a major focus for Inertial Fusion Energy (IFE). During the past year, in addition to the design studies and quadrupole analysis, the Division tested two superconducting quadrupole coils fabricated in industry as Prototypes for the HCX, and performed data analysis of the coil performance.

MIT continued to provide analysis for the use of superconducting magnets for several advanced fusion devices including the NCSX stellarator being designed by Princeton Plasma Physics Laboratory, and a superconducting version of a spherical torus fusion reactor called Aires-SCST. These studies include developing critical current algorithms for BSSCO and YBCO high temperature superconductors. The Division continued it's important role in design and development of quadrupole focusing magnets for the Advanced Hydrodynamic Facility (AHF) being designed at the Los Alamos National Laboratory. These large bore superconducting quadrupole magnets will serve as magnetic lenses for Proton Radiography imaging of test objects in real time.

The Division was the Research Institution for a NASA funded, Phase-I STTR, in collaboration with the Advanced Magnet Laboratory, Inc., a Florida based small business. The purpose of this research was to study the feasibility of an electromagnetic catapult, "MagLifter," to lower the cost of cargo delivery to space. The sled would be magnetically levitated above a guideway and propelled by a linear synchronous motor for ~2 mile to a speed of 600 mph before the first stage rocket would fire and launch the vehicle. MIT was responsible for the design of the superconducting magnetic levitation system. The Division will make a Phase II proposal during the next year to continue the design. We have already submitted another joint Phase-I STTR proposal to NASA to study a superconducting magnetic energy storage system (SMES) as a pulsed power source for the MagLifter launch concept.

A proposal was submitted to NIH for the development of a new device to separate blood components for therapeutic purposes by use of magnetic separation. Unfortunately the proposal was not funded in this round, but several reviewers gave sufficiently good scores to encourage resubmission of a modified proposal in the next funding round.

The Division's primary source of DOE funding from the OFES magnetics program remains flat for fiscal year 2001, but the funding from a variety of other programs should allow maintenance of the present staffing level.

EDUCATIONAL OUTREACH PROGRAMS

The Plasma Science and Fusion Center's educational outreach program is planned and organized under the direction of Mr. Paul Rivenberg, Outreach and Public Relations Coordinator of the PSFC. The program focuses on heightening the interest of K–12 students in scientific and technical subjects. The PSFC seeks to educate local students and the general public by conducting general tours of the PSFC laboratories. Special "Outreach Days" are held twice a year, encouraging high school and middle school students from around Massachusetts to visit the PSFC for a day of hands-on demonstrations and tours.

The Mr. Magnet Program, headed by Mr. Paul Thomas, is completing its eighth year of bringing lively demonstrations on magnetism into local elementary and middle schools. This past year Mr. Magnet presented the program to over 30,000 students at over 55 schools and other events, reaching students from Kindergarten through college freshmen. He makes a special effort to encourage girls to consider a science-related career. This year Paul Thomas traveled with his truckload of equipment to Washington, DC, at the request of the Department of Energy, to involve participants of the DOE National Science Bowl with his hands-on magnetic experiences. Closer to home, Mr. Magnet made a great impression at the Cambridge World's Fair in Central Square (Spring 2000).

The PSFC continues to work with other national laboratories to educate students and the general public. An annual Teacher's Day (to educate teachers about plasmas) and Open House (to which they can bring their students) has become tradition at each year's American Physical Society-Division of Plasma Physics meeting. Paul Rivenberg aided organizers of the 1999 education events in Seattle, and continues to work on national and international events scheduled for Quebec (October, 2000) and Washington, DC (Spring, 2001). Paul Thomas was able to attend the Seattle Open House with his large Van de Graff generator, a big hit with the students.

In Spring 2000 Mr. Rivenberg worked with Johanna Hardy of the MIT Washington Office on creating a "Summer Camp" for 5 winners of the DOE National Science Bowl. At this time he also began collaborating with the MIT

Museum on an exhibit about plasma, to open in July or August 2000. Administrative Assistant Mary Pat McNally has been instrumental in developing graphics for PSFC and other departments participating in this "Thinkapalooza" exploration space.

The PSFC continues to be involved with educational efforts sponsored by the Coalition for Plasma Science (CPS), a growing organization formed by members of universities and national laboratories to promote understanding of the field of plasma science. Associate Director Dr. Richard Temkin, who oversees PSFC education efforts, is working with this group on goals which include requesting support from Congress and funding agencies, strengthening appreciation of the plasma sciences by obtaining endorsements from industries involved in plasma applications, and addressing environmental concerns about plasma science, particularly fusion. This year CPS produced an excellent trifold about plasmas, explaining simply and graphically what plasmas are and where they are found in the universe and on earth. CPS also sponsored a well-attended congressional luncheon in Washington, DC, during which University of Alaska educator David Newman explored how the topic of plasmas can be used in the classroom to excite students about science. Paul Rivenberg has continued his duties as editor of the Coalition's Plasma Page, a summary of plasma-related news items of interest to the media. He has created a new, livelier graphic design for the page. Mr. Rivenberg is also heading a subcommittee to create a web site to help teachers bring the topic of plasma into their classrooms.

APPOINTMENTS AND PROMOTIONS

During the past year, there have been several important appointments and promotions in Plasma Science and Fusion Center program areas. The Physics Research Division appointed Johan Frenje Postdoctoral Associate and Karyn Green Research Engineer. The Alcator Division promoted Montgomery Grimes RF Engineer, James Zaks Mechanical Engineer and Stuart Sherman Programmer. The Alcator Division promoted Gary Dekow Engineering Coordinator, James Rosati Operations Coordinator and David Terry Chief Electrical Engineer.

GRADUATE DEGREES

During the past year, the following departments granted students degrees with theses in plasma fusion and related areas:

- Material Science and Engineering: Celine Fauchon, M.S.; Yoel Fink, Ph.D.
- Nuclear Engineering: Karyn Green, M.S.; Yonkyoon In, Ph.D.; Timothy MacDonald, M.S.; Robert Nachtrieb, Ph.D.; Dimitrios Pappas, Ph.D.; Rahul Advani, Ph.D.; Teresa Tutt, M.S.
- Physics: Thomas Pedersen, Ph.D.; Steven Schultz, Ph.D.; Maxim Umansky, Ph.D.

We take this opportunity to wish these graduates success in their future professional endeavors.

More information about the Plasma Science and Fusion Center can be found on the World Wide Web http://www.pfc.mit.edu/.

Miklos Porkolab

RESEARCH LABORATORY OF ELECTRONICS

The Research Laboratory of Electronics (RLE), founded in 1946, is the Institute's first interdisciplinary research laboratory. Today it is the largest such laboratory at MIT in terms of faculty and student participation. RLE grew out of the wartime MIT Radiation Laboratory and was formed to bring together physicists and electrical engineers to work on problems in electromagnetic radiation, circuits, and specialized vacuum tubes. Over the years, RLE's research interests have branched in many directions and have led to the creation of additional laboratories. Research within RLE is conducted by approximately 40 faculty members who are affiliated with the Departments of Electrical Engineering and Computer Science, Physics, Chemistry, Materials Science and Engineering, Aeronautics and Astronautics, and Linguistics. During the past year, approximately 250 graduate students and 60 undergraduates pursued research within RLE. The research is supported primarily by the Department of Defense (DoD) agencies; the Department of Energy (DOE); the National Science Foundation (NSF); the National Institutes of Health (NIH); and the National Aeronautics and Space Administration (NASA). In addition, numerous projects are funded through industry and private foundations. RLE research is widely varied and consists of two major thrust areas and several smaller focus areas. One thrust is centered on electronics and optics; the other is centered on language, speech, hearing, and sensory communication.

Detailed information about RLE research in the calendar year 1999 can be found in the *RLE Progress Report No. 142.* The report can be accessed electronically at http://rleweb.mit.edu/Publications/prog.htm.We summarize here research highlights during the past year.

ELECTRONICS AND OPTICS

Materials and Fabrication

Professor Leslie Kolodziejski is working on the design and fabrication of photonic bandgap structures. Theoretical analysis indicates that a six-fold enhancement in the emission of light should be possible, and this has been realized experimentally. The results represent an advance in the crucial problem of efficiently coupling light into photonic and optoelectronic integrated circuits.

Quantum-Effect Devices

Professor Henry Smith is carrying out research in the NanoStructures Laboratory on a wide variety of nanostructure techniques and devices. The research encompasses innovations in electron-beam and x-ray lithography, and the creation of optical devices for communications and nanostructures for information storage. Among the recent accomplishments is the development of a technique called zone-plate-array lithography, which simplifies ultraviolet and x-ray lithography, making it more accessible to academic researchers and small companies.

Optics and Devices

Professor James Fujimoto is continuing to develop optical coherence tomography, a technique for optical imaging of biological tissue that he developed in 1990, which is finding increasing applications in medical imaging. The technique is currently being applied to arterial imaging for cancer detection and surgical guidance, and to ophthalmology. During the past year he improved the resolution by a factor of close to ten, down to approximately 1 micrometer. With Professors Herman Haus and Erich Ippen, he has generated optical pulses less than 5.5 femtoseconds long at a wavelength of 800 nanometers, and 15-femtosecond pulses at the telecommunications wavelength of 1300 nanometers.

Professor Hermann Haus is working on a variety of problems important to optical communication: solitons, fiber-optical chip coupling, and timing jitter in mode-locked lasers. He has demonstrated that solitons can be stabilized against dispersive effects that have so far impeded their use for optical communications. Using computer simulations, he has achieved high efficiency in the coupling of modes between optical waveguides of very different dimensions. In addition, he has demonstrated experimentally and theoretically the limits on timing jitter of actively mode-locked fiber lasers, helping to make these devices practical for applications that require extremely accurate time delays.

Professor Erich Ippen is continuing research on ultrafast optics and fiber optics. He has developed two new fiber laser sources of short pulses, in addition to the femtosecond source developed with Professor Fujimoto, which is described above. One fiber laser is suitable for multi-gigahertz repetition-rate communications and optical signal processing; the other is intended for ultra-broadband wavelength-division-multiplexed networks.

Professor Qing Hu is continuing research on the physics and applications of millimeter-wave and terahertz devices. He has recently developed an on-chip submillimeter-wave transceiver.

Surfaces and Interfaces

Professor John Joannopoulos is continuing work on the theory of photonic band-gap structures as part of a theoretical-experimental collaboration with Professors Kolodziejski, Ippen, and Smith.

Circuits and Systems

Professor John Wyatt is continuing research on a microchip retinal implant. This device stimulates the retina electrically through microelectrodes placed directly on it. The ultimate goal is to develop a prosthetic device for patients who are blind from retinitis pigmentosa or macular degeneration. During the past year, a series of surgeries were carried out on six blind volunteers. Every patient reported some sort of visual response to the electrical stimulation.

LANGUAGE, SPEECH, HEARING, AND SENSORY COMMUNICATION

Speech Communication

Professor Kenneth Stevens is studying models of human speech production at the acoustic and articulatory levels, with the goal of extending the models to disordered speech. He is also developing models of the process by which human listeners extract word sequences from running speech. In addition to unraveling the fundamental processes of speech production, the research has application to the development of machines for speech recognition.

Dr. Joseph Perkell continues to study strategies for speech motor control, how they are influenced by properties of the production mechanism, and the role of self-hearing. He has found evidence to support the hypothesis that speech movements are programmed to achieve auditory or acoustic goals.

Dr. Stefanie Shattuck-Hufnagel is studying speech production at the phonological level. The goals include analyzing the planning that leads to production of sound segments and the processes of prosodic planning. New studies of error correction have clarified a longstanding puzzle in the modeling of sound production, and are expected to have a significant impact on cognitive modeling of speech production planning.

Sensory Communication

Research Scientist Dr. Andrew Oxenham is continuing research on auditory perception and cognition, with a particular focus on the nature of the changes in auditory waveforms as they are processed in the cochlea. The research has implications for computational auditory scene analysis and may ultimately benefit groups working on models of the human auditory periphery.

Auditory Physiology

Professor Dennis Freeman has improved the imaging of sound-induced motions of sensory cells in the inner ear so that the motion can be viewed from arbitrary perspectives, similar to tomographic reconstruction of MRI images, but at a micrometer scale. He has also developed a new type of optical microscopy—synthetic aperture microscopy—in which the target is illuminated by 10 to 100 computer-controlled laser beams. The goal is to produce gigapixel images using a mega-pixel camera, and to achieve major increases in working distances, depth-of-focus, and field of view.

Professor William Peake is studying the relationships between animals' life styles and the structure and function of their ears. A study of 37 cat species has shown that the middle ear's frequency response tends to shift toward lower frequencies with increasing animal size. The results demonstrate a structural basis for a variation in sensory capability.

FOCUS AREAS

Atomic, Molecular and Optical Physics

Professor Wolfgang Ketterle is continuing to explore the properties of atomic Bose-Einstein condensates. During the past year, he demonstrated the superfluidity of the condensate by observing a critical velocity for dissipation when a macroscopic body—a "laser knife"—moved through the condensate. He also observed a critical velocity for microscopic impurities—a wave of atoms in a different hyperfine state that propagated through the condensate. In other experiments he demonstrated that the condensate could serve as a matter-wave amplifier in an experiment that constitutes the first realization of an active matter-wave interferometer.

Professor David Pritchard has extended his studies of decoherence in elementary quantum systems by demonstrating the loss of coherence in entangled atomic systems that are spatially separated by more than a million times the size of an atom. Decoherence is a crucial issue for quantum communications and for all scenarios in quantum computing. In a separate series of experiments, he is continuing to develop techniques to advance the resolution of mass spectroscopy toward the goal of 10^{-12}.

Professors Thomas Greytak and Daniel Kleppner are continuing their studies of Bose-Einstein condensation in atomic hydrogen and the optical properties of ultracold hydrogen. The condensation dynamics of hydrogen, which are different from other gases, are being studied, and atomic interactions are being investigated through their effect on optical excitation.

Professor Seth Lloyd is working on quantum information processing, including quantum computing, and quantum control. With Professor Jeffrey Shapiro and Drs. Ngai-Chuen Wong and Selim Shahriar, he has developed a design for a quantum communications network for linking quantum computers. He has continued work on implementing quantum computation algorithms using nuclear magnetic resonance. He has worked with a group in Delft that has demonstrated a superconducting quantum bit.

Plasma Physics

Professor Abraham Bers is studying heating and current drives in magnetic confinement, ion energization in space plasmas, and intense laser-plasma interactions in inertial fusion experiments. He has analyzed the intense fields produced in inhomogeneous waveguide plasmas, and has applied the results to explain the creation of energetic oxygen and hydrogen ions in the lower magnetosphere.

Dr. Linda Sugiyama, working with Professor Bruno Coppi, has developed time-dependent numerical models for confined high-temperature plasmas. During the past year, she has found that several categories of large-scale plasma instabilities can have significantly different loss rates that are not included in usual theoretical analyses. The results can be destabilizing, but they can also be stabilizing.

Remote Sensing and Estimation

Professor David Staelin has developed a new noise estimation algorithm for data from unknown sources that yields estimates of the signal order and noise variance. The results are potentially useful for data analysis in science, engineering, medicine, finance, and manufacturing. In the area of atmospheric sensing, he has developed a new method for estimating instantaneous precipitation rates from passive microwave satellites observing in and near the opaque bands of oxygen and water vapor. The results agree well with radar data, but have the important advantage of offering full global coverage over land and sea.

Dr. Phillip Rosenkranz is carrying out research on the inversion of microwave radiometer measurements made from satellites or aircraft to obtain profiles of temperature and moisture in the atmosphere. The method has revealed stratospheric temperature waves and sea-state effects from surface emission and reflection data from the NOAA-15 satellite.

Digital Signal Processing

Professor Gregory Wornell is working on fundamental principles and algorithms for wireless and broadband communication, and multimedia signal processing. He has developed promising new classes of space-time coding techniques that have potential for dramatically increasing the capacity of wireless links without requiring additional power or bandwidth, and have low computational complexity. He has developed a suite of new interference suppression algorithms for wireless communications. He has also developed a new generation of digital earmarking technology, which is a compelling candidate for next-generation systems for copyright notification and enforcement.

Advanced Television and Signal Processing

Professor Jae Lim is addressing the need to broadcast high-definition television at resolutions higher than those permitted by the current standard. He is investigating several methods to transmit video at these higher resolutions, and is studying new video compression methods that use preprocessing techniques.

Electromagnetics

Professor Jin Au Kong is working in the areas of electromagnetic wave theory and applications. During the past year, he has developed techniques of inverse scattering for data interpretation of active spaceborne imaging radar and passive airborne radiometric experiments for the remote sensing of the earth and its oceans.

Optical Communication

Professor Jeffrey Shapiro, serving as principal investigator, has assembled a team to work on quantum information theory under a grant from the Department of Defense's Multidisciplinary Research Program of the University Research Initiative (MURI). The team includes Professors Seth Lloyd, Peter Hagelstein, and Madhu Sudan; Drs. Selim Shahriar and Ngai-Chuen Wong; and collaborators at Northwestern University and the Air Force Research Laboratory at Hanscom Field.

Working with Dr. Ngai-Chuen Wong, Professor Shapiro has developed an optical parametric amplifier concept for an ultrabright source of photon-entangled photon pairs. The technique is intended for use in quantum information processes, and represents a million-fold increase in brightness over previous sources.

Individual Research

Professor Donald Troxel has developed a remotely operated microelectromechanical system (MEMS) station, in collaboration with Professor Dennis Freeman. He has also developed a new tool for determining the reliability of very large system integration (VLSI) design.

AFFIRMATIVE ACTION

RLE has worked and will continue working to increase the number of women and minorities in career positions in the laboratory, in the context of the limited pool of qualified technical applicants and the unique qualifications of RLE's sponsored research staff. Specific measures will include: maintaining our high standards for recruitment procedures that include sending job postings to minority colleges and organizations; working closely with the RLE faculty/staff supervisor at the beginning of each search to identify ways of recruiting minority and women candidates for the new position; and being committed to finding new techniques to identify more effectively women and minority candidates. During the past year, due to limited turnover in RLE's research staff, success in affirmative action for research staff has been limited. Nevertheless, of the three research staff appointments made this year, one was made to a woman.

More information about the Research Laboratory of Electronics can be found at http://rleweb.mit.edu/.

Daniel Kleppner

SEA GRANT COLLEGE PROGRAM

The MIT Sea Grant College Program provides funds for research, education, and technology transfer directed toward wise utilization of marine resources. MIT has been a leading participant in the national program since 1969. In 1976 the Institute was designated a Sea Grant College Program. Sea Grant College status offers the potential for greater funding and confers a responsibility to work with marine researchers throughout the Commonwealth.

Funds are distributed among the 29 Sea Grant Programs in a competing grant process by the National Oceanic and Atmospheric Administration through its National Office of Sea Grant. Each program is required to match every two dollars of its federal grant with one from non-federal sources. Congress established this matching provision to ensure that Sea Grant universities would be responsive to public and industry needs. Sea Grant provides funds explicitly for technology transfer through its mandate for advisory services and education in addition to its research mandate.

In fiscal year 2000 the National Office of Sea Grant awarded MIT $1.968 Million. MIT, industry partners, the Commonwealth, and other federal (most notably ONR) and non-federal agencies provided more than $4.5 Million. In all, these funds provided partial support for 15 faculty members, 10 post-doctoral and research fellows and 33 students from MIT's Departments of Chemical, Civil and Environmental, Ocean, Mechanical and Electrical Engineering, and Earth, Atmospheric and Planetary Sciences; as well as partial support for faculty, staff and students at UMASS/Amherst, UMASS/Boston, UMASS/Lowell, Boston University, Harvard University, Northeastern University, Massachusetts Maritime Academy, Woods Hole Oceanographic Institution (WHOI), the New England Aquarium, and the Universities of Rhode Island and Maryland.

A substantial portion of the $4.5 Million is represented by the fifth and final year portion of a five year $11.6 Million award from the Office of Naval Research (ONR). This award is intended to further the development of the Autonomous Oceanographic Sampling Network (AOSN) and will involve our Autonomous Underwater Vehicles Laboratory in collaboration with WHOI, the University of Washington, the University of California at San Diego (Scripps Institute of Oceanography) and the Monterey Bay Aquarium Research Institute (MBARI). The second year of a two year $2.75 Million award from ONR for a new autonomous research vessel to be used in the Atlantic Layer Tracking Experiment (ALTEX) also contributed to this additional funding. The ALTEX project has a number of collaborators including WHOI, Florida Atlantic University, MBARI and a few commercial firms.

RESEARCH

Research at MIT Sea Grant is guided by the unique intellectual resources of colleges and universities in the Commonwealth and by the needs of the marine community. Our research is divided into two categories. The first category is our core research program, which reflects the ongoing MIT Sea Grant management process and the guidance provided by our two advisory bodies: the State Advisory Council and the Faculty Committee. Within the core research area, we have four theme areas, with quite specific concentrations: Marine Biotechnology; Coastal Management and Utilization; Coupled Ocean Observation and Modeling; and Technology Development and Management for Ocean Uses. The second research category is our Focused Research, intended to address major regional and/or national issues or needs. Projects under focused research are also called Marine Center projects. In addition, Automation in the Manufacture of Marine Systems, now supported entirely from sources outside Sea Grant, continues to be one of Sea Grant's strongest activities. We continue to build upon advances made in these areas. In addition, MIT Sea Grant has successfully competed for and been awarded additional grants in these and several other areas.

Sea Grant's research objective in Marine Biotechnology is the advancement of technology that can contribute to better use of the biological resources of ocean and coastal ecosystems. Recently completed research has included studies of novel delivery systems for the vaccination of farmed fish and novel and potentially important research in seaweed as a source of compounds having commercial potential in food processing and pharmaceuticals. Three research projects, begun in March of 1998, were completed in February of this year. Professor Ralph Mitchell, Gordon McKay Professor of Applied Biology at Harvard University, completed his research on environmentally acceptable methods of antifouling based on the activity of metabolites from marine microorganisms, *Development of Novel Environmentally Acceptable Marine Antifouling Coatings Based on Microbial Metabolites.* Professor Don Cheney, Northeastern University, completed his research activities in nori aquaculture, *Effect of Nori Aquaculture on the Marine Flora of Cobscook Bay and Selected Sites within the Gulf of Maine,* which was done as a component of a Non-indigenous Species grant with investigators from the Universities of New Hampshire and Maine. Thirdly, Professor Herb Hultin of the University of Massachusetts at Amherst completed his research into uses of

traditionally little used fish species with his project, *Overcoming Problems in Producing High Quality Functional Proteins from Small Pelagic Fish.*

On-going research in this thematic concentration included a project begun in March of last year—*Tissue Engineered Fish Skin*—lead by Professor Robert Langer of the Chemical Engineering Department here at MIT with Professor Michael Triantafyllou of the Ocean Engineering Department as co-principal investigator. The objective of this research is to examine the feasibility of developing an artificial version of fish skin using tissue-engineering techniques. This research, continuing into its second year, builds upon successful developments in human skin replacement using polymer chemistry technology to provide a support structure for dermal fibroplasts. These techniques, already approved for human use, could provide for breakthroughs in surface coverings for a new class of aquatic robots. This project is scheduled for completion in February of 2001. The inclusion of Professor Triantafyllou in the research project recognizes the coupling of Langer's objectives and methodology with that of Triantafyllou's companion project to be discussed under the Technology Development and Management for Ocean Uses theme area—*Biomimetic Hull and Actuators for Fast-maneuvering Vehicles*—that includes Professor Langer as co-principal investigator

Our solicitation for new proposals last year resulted in a new research project in Marine Biotechnology—*Production of High Value Food Proteins from Low Value Underutilized Fish*—submitted by Professor Herb Hultin of UMASS/Amherst. A recent process to produce fish protein isolates free of most insoluble components such as oil, membranes, skin, bones, and low molecular weight soluble impurities has been proposed based on the solubility of fish muscle proteins. This new project examines the problem caused by proteins of the fish tissues used that may not be easily separable from the desired proteins. These include the heme proteins and proteolytic enzymes. Due to density considerations, some insoluble pigment components are also difficult to remove. This project is a regional research project in that it involves supporting research by Professor Tyre Lanier of North Carolina State University and Professor Jae Park of Oregon State University, both funded by their respective Sea Grant programs.

Research projects within the Coastal Management and Utilization theme area seek to advance the science and engineering needed to more effectively utilize our coastal and ocean resources and, either as an integral component or separately, increases our understanding of the marine ecosystem and our ability to influence its sustainability. Professor Ole Madsen, MIT Department of Civil and Environmental Engineering, completed his research into the effects of seawalls on coastal sediment transport—*Effect of Sea Walls on Longshore Currents.* Professor Ivan Valiela of Boston University along with Professor Harry Hemond, MIT Department of Civil and Environmental Engineering, completed their two-year study, *Denitrification and Nitrogen Attenuation in the Aquifer of an Estuarine Watershed.* Professor Joseph Montoya, Harvard University, had been awarded a one-year grant, *A Preliminary Stable Isotope Tracer Study of Sewage Nitrogen Inputs to Massachusetts Bay that* investigated the use of stable isotopes as tracers of sewage nitrogen as distinct from marine nitrogen within the Massachusetts Bay ecosystem. Montoya followed this work with a successful proposal to continue his research with a two-year grant beginning in March 1997. Professor Montoya has since left Harvard to accept a faculty position with Georgia Technical Institute effective for the fall semester of 1998. Harvard requested the substitution of Professor James McCarthy as PI through to the completion of the project. Subsequent to this change in project leadership Harvard had requested an extension to January 2000 and had also revised their budget downwards reflecting their having found additional funding sources. This project is completed.

Continuing into its second year is a research effort lead by Professor Philip Gschwend, Department of Civil and Environmental Engineering, MIT—*Sediment Quality Criteria (SQCs) for Policyclic Aromatic Hydrocarbons (PAHs): Accounting for Pyrogenic Sources.* The primary objective in this research is to investigate how the effects of combustion-derived soot can be incorporated into predicting the exposures of marine benthic organisms to these toxic substances.

Our solicitation for new research to begin March of 2000 resulted in two projects in Coastal Management and Utilization. *Combined Wave-Current Flows Over a Movable Rippled Bed*—lead by Professor Ole Madsen of the Dept. of Civil and Environmental Engineering at MIT—attempts to extend the completed research into combined flows over fixed, artificial rippled beds to the more realistic case of beds consisting of movable sediments. These ripples, more closely representative of actual conditions, have the potential to change bottom geometry and hence flow resistance in response to the nature of the flow.

The second successful proposal in this theme area, *Quantitative PCR Combined with Constant Denaturant Capillary Electrophoresis for the Analysis of Naturally Occurring Pathogens in Coastal Environments*—with Professor

Martin Polz of the Dept. of Civil and Environmental Engineering at MIT as the Principal Investigator—intends to develop and apply molecular techniques that allow the quantification of diversity and abundance of pathogenic vibrios in marine environmental samples. This work is of great benefit in that the ability to quantify pathogenic organisms in the environment will aid in understanding patterns of transmission.

Our annual call (issued in February of each year) for new research and outreach proposals to begin in March of 1999 included a new theme area, Coupled Ocean Observation and Modeling, as the newest theme area in our core program. Now in its second and final year, *Integrated Mapping and Navigation for Autonomous Underwater Vehicles*, led by John Leonard, Associate Professor of Ocean Engineering, MIT, illustrates the tight coupling of this new theme area with the traditional activities of the Autonomous Underwater Vehicle (AUV) program at MIT. The objective of the proposed research is to develop an algorithm for integrated mapping and navigation (IMAN) for AUVs and to verify its performance with real data. The ultimate aim of integrated mapping and navigation is to enable AUVs to build and maintain feature-based maps of the ocean environment from sonar data and to use these maps to navigate for long duration missions over large areas of the ocean.

In our solicitation for new research to begin in March of this year there were two additions in the Coupled Ocean Observation and Modeling theme area. *Acoustic Sensing of Sediment Properties Using a WWW-Controlled Shallow Water Mooring* led by Professor Henrik Schmidt of the Ocean Engineering Dept. at MIT combines the Poseidon distributed oceanographic information system (refer to the Focused Research/Marine Centers section for a description of Poseidon) with a new instrumentation mooring for littoral environments to provide a unique facility for remote small-scale sensing capabilities for sediment characterization. The second successful proposal in this thematic area represents an interesting melding of two separate activities—one being the continuing development of AUV technology and its applications; the other being the relatively new efforts to incorporate what we have developed into an Autonomous Surface Craft (ASC) for similar ocean related work. This proposal—*Autonomous Underwater Vehicle Navigation and Control Using an Autonomous Surface Craft*—originally proposed and led by Dr. James Bellingham, Principal Research Engineer and Manager of the MIT AUV Laboratory, will utilize the RF communication capabilities of a surface platform (in this case the ASC) and acoustic communication techniques to further the mission capabilities of the subsurface instrumentation.

Current efforts continue to focus on developing the key technologies for Autonomous Ocean Sampling Networks (AOSN). The MIT Sea Grant AUV Lab, sponsored by ONR and, in part, by NOAA through the Sea Grant College Program, leads this multi-university research effort. The goal is to further our ability to carry out real-time oceanography over the long term, through the synergistic combination of AUVs, moorings, gliders, and satellites. Collaborators have included the Woods Hole Oceanographic Institution, the Institute of Ocean Sciences (Sidney, BC), Harvard University, the Scripps Institution of Oceanography, the University of Washington Applied Physics Lab, the Smithsonian Institution, MBARI and National Geographic Society. Professor Henrik Schmidt, MIT Department of Ocean Engineering, oversees this research area as Associate Director for Research. During the past year the day to day management and technical direction of the AUV team has passed from Jim Bellingham (Principal Research Engineer and AUV Lab Manager) to Justin Manley (Research Engineer) and continues with support from a number of Research Engineers, Visiting Engineers and Scientists, several Post-Doctoral Associates, Research Fellows, Research Specialists, and graduate students, as well as undergraduate students.

Lastly is a theme area we have traditionally included in our proposal solicitation that is deliberately broad in focus and title—Technology Development and Management for Ocean Uses. This theme area is meant to serve as an avenue for new and exciting ideas, and has, on occasion, yielded successful proposals that have evolved into continuing research theme areas. Our solicitation for new research to begin on March 1, 1997 did indeed result in a successful proposal in this theme area. This research, *Development of Particle Tracking Equipment for Flow Visualization Around Live, Unrestrained Fish*, led by Professor Michael Triantafyllou as Principal Investigator with Dr. Thomas Consi as Associate Investigator, both of the Department of Ocean Engineering, was completed in February of 1999. This work followed a previous Sea Grant project that provided valuable insight as to how fish are able to display accelerations and sustained velocities that seem impossible from the viewpoints of available energy and conventional understanding of locomotion processes. Later research focused on better visualization and analysis of the flow of fluid through which live, unrestrained fish swim. This required development of sophisticated instrumentation and software to allow individual water particles to be illuminated and their motions precisely measured in space and time. The objective of this research was twofold: to better understand the mechanisms fish employ in their natural habitat is important to our appreciation of them as a species; secondly is the benefit to be gained in applying this knowledge to man-made vehicles to make better use of energy. Although this had been reported in last year's research summary it is referred to again because of the sound basis it has provided for current

funded research projects and even more provocative potential research involving fish physiology. Reference should be drawn to the research being led by Professors Langer and Triantafyllou reported on elsewhere in this report.

Our solicitation for new research to begin on March 1, 1998 resulted in two successful proposals (both of which have completed their second and final year) in this theme area: *Computational Analysis of In-Situ Holograms of Marine Micro-organisms*, led by Professor Jerome Milgram, Department of Ocean Engineering, and *Submerged Coastal Offshore Mussel Aquaculture System: A Multi-Disciplinary Approach*, led by Dr. Walter Paul, Applied Ocean Physics and Engineering Department, Woods Hole Oceanographic Institution.

Professor Mailgram continued his research on marine application of holography where the emphasis is on computational modeling, code development and numerical testing. The first two technical utilizations will be for three-dimensional particle image velocimetry for complete measurement of flow fields, and for studying the interaction of marine microorganisms, largely plankton, with their fluid environment.

The proposal from Dr. Paul deserves particular note in that it satisfies the definitions of a "regional proposal" —a concept encouraged and specifically supported by the National Office. The intent of the regional concept is to provide an incentive for more than one program to collaborate on an issue or problem of regional importance (often with significance to other regions around the nation). Dr. Paul's proposal involves both marine biology and marine policy to compliment his emphasis on the physical oceanography and engineering aspects of offshore mussel aquaculture. We are funding Dr. Paul's portion, WHOI is funding the marine policy portion and the Commonwealth is funding the biology portion.

In response to our solicitation for projects to begin in March of 1999 a proposal submitted by Professors Michael Triantafyllou of the Ocean Engineering Department and Professor Robert Langer of the Chemical Engineering Department—*Biomimetic Hull and Actuators for Fast-Maneuvering Vehicle*—received favorable reviews and was included in the Omnibus Proposal sent to the National Office in November of 1998. This project will develop and test novel muscle-like actuators first using motors and then shape memory alloys. It will then develop a synthetic skin structure with installed flow sensors on the hull of a robotic vehicle, the *Robotuna*, and study the use of such a biomimetic skin for use with a flexible hull form.

FOCUSED RESEARCH/MARINE CENTERS

The objective of the Focused Research/Marine Center concept is to plan and conduct research programs in collaboration with, and jointly sponsored by, industry and government agencies in order to attack major problems of broad interest to the marine community, and to foster industrial competitiveness by transferring the resulting technology to users.

Autonomous Underwater Vehicles: Basic Technologies, our second Focused Research project concluded in 1996. It served to develop robotic multi-use platforms, the Odyssey class of Autonomous Underwater Vehicle (AUV) for coastal as well as deep-ocean applications. Lessons learned from these vehicles have been incorporated into Odyssey II, which was built under the third Focused Research Program project, *Autonomous Underwater Vehicles: Scientific and Industrial Applications*, completed in July of last year. This Focused Research Project had also been supported as a Tactical Research Project of the National Sea Grant Office, entitled *Rapid Response to Seismic Activity on the Juan de Fuca Ridge*. A recent Focused Research project, *Development of Autonomous Surface Craft*, resulted in a prototype and field studies conducted in local waters. We have decided that this research effort more appropriately belongs within the broader research focus of the AUV program where the field infrastructure better exploits its anticipated capabilities.

The Autonomous Surface Craft (ASC) has concentrated on establishing a useful function in coastal survey and exploration activities. These efforts have mostly been confined to hydrographic surveys. Laboratory developments and fieldwork have produced a prototype system adequate for actual survey trials. These have produced both hardware and software components that provide a solid basis for the next stage of activity. A new mission for the ASC has been added. This involves using our prototype as a mobile communications station for our AOSN project.

As a consequence of the success of the Focused Research Programs that addressed AUV technologies and applications we have been able to capture additional funding. Today the AUV Laboratory is supported by ONR and others at an annual rate of more than $2.5 million. This illustrates the intent of our Focused Research theme area and further demonstrates how early funding of well thought out research areas can establish the soundness of more specific research and development objectives.

On August 1, 1996 the initial, first year work began on the fourth Focused Research/Marine Center, *Behavior of Capped Contaminated Sediments*, under the leadership of Senior Research Engineer and Lecturer, Dr. E. Eric Adams of MIT. This research is intended to address theoretical analysis and field studies to determine the processes occurring in a capped contaminated sediment site. It follows a recently completed Focused Research Marine Center, *Contaminated Sediments in Boston Harbor*, led by former MIT Professor Keith Stolzenbach. A full history, results, and recommendations are now available in an MIT Sea Grant publication by the same title. This work will allow a fuller understanding of the site selection criteria, transport processes of contaminated material through the capping material and further aid in predicting benthic impacts. The University of Massachusetts/Boston and the School of Public Health, Harvard University are collaborators on this project.

A more recent Focused Research/Marine Center, *Poseidon: A Coastal Zone Management System via the World Wide Web*, initiated work in March of 1998. This project is a consequence of the high availability of raw ocean data, the various modeling approaches one can apply to large, multi-parameter data sets, and extensive uses such data-derived knowledge make possible (weather forecasting, fisheries management, environmental impacts, etc.). We have presented the vision supporting this research, and the results as they evolve at the Collegium symposia and workshops recently. There is a growing interest in this area as evidenced by the requests for more detailed information from our colleagues outside of MIT.

The following year we again included the opportunity for new Focused Research proposals in our program solicitation for new research and educational proposals. We received one such proposal, *Distributed Observatories for the Coastal Environment* (Jim Bellingham, MIT AUV Lab. Manager). This project received favorable peer reviews and was included in our recent Omnibus Proposal to the National Office. It too reflects the latest addition to our core research theme areas in that it is specifically oriented to the coastal regime and embodies an integrated approach to a real-time multi-disciplinary network for advanced study of a complex marine environment, in this case the Stellwagen Bank National Marine Sanctuary. This represents a unique opportunity to involve a network of advanced research tools such as the Autonomous Underwater Vehicle, in-situ observation platforms and remote sensing methods in a two-way telemetry system for use by many, possibly unrelated, researchers. This project is now funded and activity began in March of 1999.

NATIONAL STRATEGIC INITIATIVES

In the competition for new funded research as part of the 1999 National Strategic Initiative we were fortunate to receive favorable reviews for our proposal, *MIT Sea Grant Technology Program in Sea Scallop Mariculture,* with Professor Chrys Chryssostomidis and Cliff Goudey as co-principal investigators. The objectives of this program are to develop, refine and foster the commercialization of several innovative technologies needed by the Northeast sea scallop industry for its conversion to a sustainable, more economically viable industry. The technologies include improved harvesting systems for scallop seed and market-sized scallops, scallop bed monitoring, predator control and seed transport. This project enjoys significant collaboration with a number of experts and practitioners in the industry. The project began in March of this year and has an eighteen-month duration.

The proposal solicitation for National Strategic Initiatives during the current year (2000) yielded a number of interesting preliminary proposals, which were reviewed, and rank ordered by panels at the National Office of Sea Grant. Our program is very fortunate to have received funding for two of the proposals submitted: *"Environmental Marine Biotechnology: Development of Oligonucleotide Gene Chips as Sensors for Diverse Marine Pathogens"* with Professor Martin Polz of the Civil Engineering and Environmental Engineering Department at MIT and Professor Ee Lin Lim, formerly associated with MIT and Professor Polz, and now with Temple University; and *"Environmental Marine Biotechnology: Mussel Plasma Histidine-rich Glycoprotein (HRG) - Biomarker, Key to Metal Transport, Novel Natural Product"* submitted by Professor William Robinson, Professor Manickam Sugumaran and Professor Gordon Wallace all of UMASS/Boston.

Professor Polz's proposed research will address the early detection and monitoring of pathogens in coastal ecosystems using DNA microarrays and sophisticated quantitative polymerase chain reaction (PCR) analysis for enumerating gene copy number as a proxy for cell abundance. The ultimate goal of this research is to establish a technology to permit assessment of global distribution as well as the local variation of a variety of pathogenic populations in an efficient and cost-effective manner.

The research proposed by the UMASS/ Boston team led by Professor Robinson proposes to establish a biomarker of metal exposure and toxicity. Prior research by this team has succeeded in isolating and purifying histidine-rich glycoprotein (HRG) from an invertebrate, the *musselmytilus edulis*. This protein has been shown to strongly bind to

metals such as cadmium. This proposed research would involve advanced molecular/cellular biology and metal analytical techniques in the study. The team of three represents aquatic toxicology, molecular biology/protein biochemistry and inorganic geochemistry.

EDUCATION

Sea Grant is committed to providing learning opportunities for students, professionals, and the public. Support for graduate students is included in almost every research project. In addition, the program continues to provide major support for marine-related Undergraduate Research Opportunities Program (UROP) projects. Sea Grant UROP directly provided $25,000. A substantial contribution from the Department of Ocean Engineering and the MIT UROP itself raised this to a total of $50,000. Sixteen UROPs were supported this year representing five MIT departments.

Completed in February of this year was a one-year educational project proposed by Cliff Goudey as Principal Investigator assisted by Brandy Moran as Associate Investigator, both members of the MIT Sea Grant Advisory staff. *Aquaculture Courses for Massachusetts High School Students* recognizes the need to view aquaculture in terms of its potential for economic benefits and the support necessary from a well-informed citizenry. The specific objectives of this project were to focus on the educational needs of the general public and the methods best used to provide it. Course offerings aimed at high school students that actually exposed them to a prototype marine finfish recirculating system located on Boston Harbor coupled with the development of course materials is seen as the essential first level of involvement in this activity. As courses were to be developed and demonstrated they are made available to local high schools through the contacts obtained from the New England Board of Higher Education AQUA (the New England Aquaculture Educators Network) organizers and the Boston National Historic Park special events coordinator.

We again requested new educational proposals in our annual solicitation issued last year for projects to begin in March of 2000. The Quincy Public Schools submitted an excellent proposal—*Develop and Implement Local Marine Curriculum for Quincy Public Schools*—in collaboration with a commercial partner, Photography by Michelson, Inc., owned by Mr. Robert Michelson who our Program had supported with seed funding to develop and test a grade school classroom approach to marine science education. Michelson had established the efficacy of such an approach as evidenced by the strong endorsement his preliminary efforts enjoyed. The goals and objectives of the current project are: firstly to establish a clear and comprehensive awareness and understanding of the marine ecological environment for teachers and administrators; secondly to develop and field test course units; finally to establish a monitoring program that includes high school, middle and elementary students to continue their knowledge of marine life and the career paths that are available to well educated and prepared young men and women. This is a two-year program with considerable participation by teachers.

Every year the National Office of Sea Grant issues a solicitation for a program intended to fulfill its broad educational responsibilities and to strengthen ties between academia and industry—the Sea Grant Industry Fellowship. This program is available to graduate students who are pursuing research and development projects on topics of interest to a particular industry/company. A full partnership needs to be in place with a faculty advisor, the Sea Grant college or institute, the industry partner and, of course, the student. Professor Nicholas Patrikalakis as Principal Investigator, Douglas Webb, President of Webb Research Corp. and our Sea Grant program submitted a proposal to involve Ocean Engineering graduate student Robert Damus in a two year project, *Sea Grant Industry Fellow: Communication Protocol and Technologies for Low-Power Untethered, Mobile Ocean Platforms.* This proposal was successful and having begun in September of last year will run through August of 2001.

ADVISORY SERVICES AND TECHNOLOGY TRANSFER

The MIT Sea Grant Marine Industry Collegium promotes the active transfer of marine research and technology through the sponsorship of workshops, the distribution of publications and research reports, and direct interaction with members. Since 1975, the Collegium has provided member organizations with the opportunity to attend several technical workshops and symposia per year. The Collegium program collaborates with Draper Laboratories and other campus organizations in sponsoring symposia and workshops.

A new program to encourage and fund cooperative research between commercial fishermen and ocean researchers has been started with an fiscal year 2000 appropriation to the *Northeast Consortium* funded through the NOAA National Marine Fisheries Service with the assistance of New Hampshire's Senator Judd Gregg. The *Northeast Consortium* is an informal association of collaborators with representation from Sea Grant member institutions in the Northeast (Massachusetts, New Hampshire, Maine,) having a common goal of assisting the establishment of

partnerships among stakeholders in the management of commercial fisheries in the Gulf of Maine. During the later half of FY2001 a solicitation will be issued for proposals to encourage the use of commercial fishing vessels in ocean research, monitoring and management, and to conduct research leading to the development of selective fishing gear.

The Center for Fisheries Engineering Research (CFER) has strengthened its role in regional fisheries and aquaculture through several important initiatives and capacity building. Since its establishment in 1982, CFER project director Cliff Goudey has varied the emphasis depending on the needs of the fishing industry. Early topics included vessel safety, fuel efficiency, and fishing gear selectivity. More recently bycatch reduction, ecosystem effects of fishing, stock enhancement, and aquaculture have become more important.

CFER has established a marine finfish hatchery on Boston Harbor aimed at species and recirculating technology research and outreach. Aquaculture specialist Brandy Moran, hired to manage the facility and develop educational programs, continues to provide an on-going demonstration facility in support of our broad educational goals and to serve as a small-scale example of a potentially viable commercial activity. CFER's collaborations with the fishing industry include: developing a low-impact scallop dredge; demonstrating sea scallop enhancement techniques in a nine-square-mile EEZ site; and evaluating acoustic techniques for detecting the presence of right whales. As our part of a National Ocean Partnership Program (NOPP) funded project we are involved in the development of a system for fisheries data telemetry from commercial fishing vessels. Ken Ekstrom, an electronics/software specialist, continues to assist in this NOPP-funded project.

Collaborative work with the Massachusetts Aquaculture Coordinator, Scott Soares, has successfully identified the regulatory environment for aquaculture permitting in the Commonwealth. This activity was supported by a two-year funded project—*Aquaculture Permitting Guidelines for Massachusetts*—completed in February of this year. Draft permitting guidelines have been developed and are under review. Their production is scheduled to occur shortly together with an interactive web site. Test-case identification awaits the finalization of the guidelines.

The Center for Marine Social Sciences (CMSS) is actively pursuing its goal of applying advances in social sciences to help resolve marine-related issues and to contribute to policy development. CMSS continues to work with state and federal agencies and the public to identify and address local and regional needs in fisheries and coastal zone management. Marine advisory agent Madeleine Hall-Arber continues to track the social impact of new fisheries regulations and is currently working on a project to study fishing-dependent communities in New England. Hall-Arber is vice-chair of the New England Fishery Management Council's Social Science Advisory Committee, Social Science Editor for American Fisheries Society's *Fisheries* journal and is an active member of both the Atlantic States Marine Fisheries Commission's Committee on Economics and Social Sciences, and Women's Fisheries Network. Public education efforts continue through exhibits, participation in conferences and festivals, maintenance of an active e-mail discussion list, and articles in Commercial Fisheries News.

A new web page for Women's Fisheries Network is being developed with the participation of several of the members and the governing board. Traditional outreach continues as well with representation on the Atlantic States Marine Fisheries Winter Flounder and Herring Technical Committees, and the New England Fishery Management Council's Overfishing Definitions Subcommittee. In addition, Hall-Arber frequently serves as an informal advisor to students and journalists on social science and fisheries issues, and oversees the use of the Zebra Mussel Mania Traveling Trunk.

Zebra mussels, an aquatic species that invaded North America in 1988, have caused serious economic and environmental problems. They are rapidly spreading beyond the Great Lakes region into many waterways in the Midwest, and even into the Northeast (zebra mussels have already been found in the Connecticut River and Lake Champlain). MIT Sea Grant is tuning kids into zebra mussels and other exotic species through a new and exciting teaching aid called the Zebra Mussel Mania Traveling Trunk. Developed by Illinois-Indiana Sea Grant and the Illinois River Project with input from fifth- and sixth-grade teachers who contributed to curriculum development and related activities, the trunk is filled with ten hands-on activities that provide educators with tools to teach about the full range of problems associated with zebra mussels and other nonindigenous species. Use of the trunk encourages students to inquire and discover. What makes the trunk even more effective is the integration of other subjects, including math, English, social studies, and the arts.

Through experiments, games, stories, and a host of other interesting activities, students are able to understand problems caused by nonindigenous species and can learn how to become involved in solutions to prevent the spread of these species through community action projects.

The MIT Sea Grant Communications/Information Service, under the leadership of Andrea Cohen, produces outreach materials for a wide variety of consumers. This includes the newsletter, *Two if by Sea*, published jointly by the MIT and WHOI Sea Grant Programs. *Two if By Sea* highlights the research, advisory and outreach activities of Sea Grant programs in the Commonwealth, and provides the public with information about coastal and marine issues in the region. Communications recently published a new *Program Report*, which describes the program and our current projects and areas of focus.

Communications redesigned the entire MIT Sea Grant web site, making it more useful and interactive. Users can now search our publications directory and Citizen's Guide to Sources for Marine and Coastal Information in Massachusetts on-line. Communications produces and distributes all of the program's technical reports and distributes and archives all program publications. In the past year, we have received a significant number of publication requests on-line. We also provide information to schools, businesses, government, citizens, media, the MIT community and others on a wide range of marine-related topics. We maintain a reference center with journals and books, which is available to the community for informational purposes.

In September, Communications was awarded a grant from the regional Sea Grant programs to design and maintain a new regional Sea Grant site that features a new topic each month. That site has been chosen as a model for the four other regional Sea Grant sites.

This past year, Communications collaborated with the Metropolitan District Commission (MDC) and The Friends of Magazine Beach, a community group, in sponsoring the fifth Annual Clean-Up of Magazine Beach and the Banks of the Charles. This ongoing collaboration helped lead to an agreement between the MDC and the City of Cambridge, whereby the City has committed $1.5 million to renovate this area.

In collaboration with the New England Aquarium (NEAq), Communications co-sponsored the Third Annual World of Water Film Festival. Communications also collaborated with NEAq in organizing and leading a workshop in the Fourth Annual Environmental Writers' Conference.

Media relations have resulted in print, web and television coverage of MIT Sea Grant Projects in many venues, including: *The Boston Globe, New England Cable News, ENN Radio Site, Earthwatch Radio, The Environmental News Network*, PBS (*Scientific American Frontiers*), and *National Fishermen.*

In April, our communications specialist, Elisabeth Sylvan, took a research position at MIT; we are currently meeting our web needs through a freelance consultant. In May, administrative assistant Christine Cristo left the program; a temporary freelance assistant is now helping with publication efforts and other administrative tasks for advisory services.

The goal of the MITSG Center for Coastal Resources (MITSG CCR) is to serve as a link between scientific and technical research and information and the user community, such as state and federal agencies, local government, non-government organizations and citizens. The MITSG CCR provides outreach and educational activities in three general areas; water and sediment quality, marine bioinvasions and biodiversity, and impacts of fishing on communities. Specific activities have included convening conferences, organizing 20 scientists and students to survey native and non-native organisms on fouling docks, and editing a Proceedings of the First National Conference on Marine Bioinvasions and a book entitled, *The Decline of Fisheries Resources in New England: Evaluating the Impact of Overfishing, Contamination, and Habitat Degradation.* The MITSG CCR maintains a web site (http://massbay.mit.edu/) that highlights research by the marine center on behavior of capped contaminated sediments, marine bioinvasions, and general linkages to other organizations, including those with data on water and sediment quality. Many of these projects are undertaken with state and federal agency support. Future activities include preparing a report on the recent Rapid Assessment Survey of Fouling Organisms on Floating Docks, convening a task force to prepare an Aquatic Nuisance Species Management Plan for Massachusetts, and summarizing the scientific and technical information from the Marine Center studies on the use of Confined Aquatic Disposal Cells.

The joint educational program established with the Massachusetts Maritime Academy (MMA) twenty years ago has grown in terms of the educational/training needs it addresses and in its participation. During the past year MMA continued to expand a series of seminars oriented towards their traditional constituency of recreational and commercial users of coastal waters. Recent offerings have begun to address aquaculture and fisheries issues.

MMA's annual Saltwater Fishing Seminar is now in its 21st year and continues to draw large numbers of participants every year. Shellfish Farming Forum and Aquaculture Symposium events held this past winter drew considerable interest. Most recently the Massachusetts Shellfish Wardens Association requested the Sea Grant/MMA program to develop a training program for the more than 60 shellfish wardens in the Commonwealth to better prepare them for managing local town shellfish resources.

PROGRAM MANAGEMENT

The program director is Professor Chryssostomos Chryssostomidis, Department Head, Ocean Engineering. Associate directors for research are Professor Henrik Schmidt and Dr. E. Eric Adams. Richard Morris continues to serve as Executive Officer for the program. Timothy Downes continues as the program's Administrative Officer.

MIT Sea Grant administers the Doherty Professorship endowed by the Henry L. and Grace Doherty Foundation. In the last competition there were two outstanding nominees for consideration so much so that both have been awarded the two-year Professorship. Assistant Professor Martin Polz of the Civil and Environmental Engineering Department submitted a proposal—Quantitative Ecology of Harmful Microorganisms in coastal, Marine Environments—that addresses the need to improve our ability to detect and characterize the causes of marine related illnesses and harmful algal blooms before they are manifested in major outbreaks. His research will focus on the use of quantitative polymerase chain reaction (PCR) techniques for detection and quantification of microbial populations. This research project will concentrate the fieldwork in the New England waters.

The second Doherty Professorship was awarded to Professor Nicholas Makris of the Ocean Engineering Department. His proposal for the Doherty award—*Monitoring Natural and Manmade Noise in Massachusetts Bay*—will conduct a series of field experiments on Stellwagen Bank in high-resolution real-time spatial and temporal measurements of both natural and anthropogenic ocean noise. Stellwagen Bank is a National Marine Sanctuary with a variety of marine species. This research will attempt to distinguish populations of marine life in terms of species identification, abundance and behavior. It will also determine the impact of the manmade ocean noise on various marine life—in particular the mammals present on the Bank, and in many cases threatened with further population declines.

John J. Leonard, an Associate Professor of Ocean Engineering completed the second year of his Doherty Professorship. Professor Leonard's research concerned the unique ability of certain animals, dolphins in particular, to combine controlled movement of the animal with their sonar capability to determine size and shape of objects of interest.

More information about the Sea Grant College Program can be found on the World Wide Web at http://web.mit.edu/seagrant/www/.

Chryssostomos Chryssostomidis

TECHNOLOGY AND DEVELOPMENT PROGRAM

The Technology and Development Program's (TDP) primary mission is to provide a focus at MIT for research and education related to the role of technology in the socioeconomic development of newly industrialized nations. TDP works with other academic departments and research centers throughout MIT to:

- Promote an awareness of the relationship between science, technology, and development on the part of faculty and students at MIT;
- Provide a focal point for the technology and development activities of faculty, students, and visiting scholars interested in the field of technology and development;
- Assist the faculty, students, and staff of collaborating institutions in other countries to develop research and academic interests consistent with their national needs; and
- Serve as a contact for interested organizations outside MIT (government, academic, private sector) to access the Institute's resources and its knowledge of developing countries—particularly of their socioeconomic and technological problems.

TDP carries out these objectives through research, academic programs, and contacts with international and national organizations that have an interest in broad areas of technology and development. In order to fully utilize available resources, the TDP is structured to interact with other academic departments and research centers throughout MIT.

CURRENT RESEARCH PROGRAMS

The two major on-going programs are in Thailand and Malaysia.

TDP in Thailand collaborates in research and education with two major Thai Institutions; The Collaborative Program of Science and Technology with the National Science Technology and Development Agency of Thailand (NSTDA); and the Collaborative Program of Science and Technology with the King Mongkut University of Technology at Thonburi (KMUTT). These two programs are funded under an agreement with Suskapatana Foundation, and both started in 1996. Both activities are currently being continued at slower pace due to the economic hardship in Thailand. TDP continued its assistance to KMUTT in organizational of its research and academic programs and the start-up of a research center operating under the auspices of KMUTT Professor Alan T. Hatton successfully completed the second year of the Chemical Engineering Practice School in Thailand. Professor Chris Scott concluded his work on "Morphology Control in Immiscible Polymer Blends Through Interfacial Reaction and Rheology" and Professor Kevin Amaratunga continued his work on the Thailand Integrated Water Resource Management System Project.

Interaction between Professor Steven Lerman and NSTDA continued in the area of "Multi-Media Technology."

Since signing a multi-year Agreement with MUST-Ehsan Foundation in January 1997, TDP has been assisting the Foundation with the establishment of the Malaysia University of Science and Technology (MUST). To Support the Establishment of the Malaysia University of Science and Technology, TDP and MUST have devoted their efforts to developing; the academic programs at the graduate level in several engineering areas including Information Technology and Multi Media; Biochemcial and Biotechnology; Engineering Systems and Operations; and Transportation and Logistics; the research agenda focusing on infrastructure; information technology/multi-media; Biotechnology and Chemical Engineering; Advanced Materials; Manufacturing; and Energy and Environment; as well as working on institutional building activities, and promoting industrial and governmental collaboration and linkages. Due to economic hardship in Malaysia, TDP's activities have been carried out at a much slower pace. Currently TDP is discussing the possibility of funding from the government of Malaysia and Motorola Corporation. Should these funding materialize we expect to continue on collaboration at the normal pace. Recently the Government of Malaysia has approved equivalent of $28 Million US Dollars for support of Malaysia University of Science and Technology. We are currently awaiting the final approval of Motorola for an additional $25 Million US Dollars before we restart the activities of the program.

FUTURE RESEARCH INITIATIVES

The Technology and Development Program has had several preliminary discussions with appropriate institutions in Colombia, Egypt, and Kuwait.

In conjunction with ABT Associates TDP has explored the possibility of establishing a Science and Technology Institute based graduate University in the Middle East most likely in Golan Heights. As part of a peace process that is ongoing in Washington. The State Department has requested a somewhat more detailed proposal. In Colombia,

TDP and Mariano Ospina Foundation have jointly prepared a proposal to establish an Institute for research and education on large-scale infrastructure systems in Bogota. In Egypt, the office of the Prime Minister has asked for a briefing on the possibility of establishing a University similar to the Malaysia University of Science and Technology. We are at a preliminary stage of discussion

CURRENT EDUCATION INITIATIVES

The TDP-sponsored Middle East Program at MIT completed its eleventh year. The program (under the direction of Professor Nazli Choucri, TDP Associate Director) involves faculty from the Department of Political Science, Department of Economics, the History Faculty, the Department of Urban Studies and Planning, the Sloan School of Management, the Department of Civil and Environmental Engineering, the Science, Technology and Society Program, and the Aga Khan Program in Islamic Architecture. . The program enables students with an interest in the Middle East to develop an expertise in the area in addition to their own academic fields of specialization; and it examines the processes of socio-economic change, technological development, political change, institutional development, capital flows, and business and investment patterns in the region.

A number of short courses and executive seminars have been offered both in Thailand and Malaysia including, Project Management for Capital Projects (Professor Robert D. Logcher); Fundamentals of Lasers, Fiberoptics, and Photonic Sensors (Professor Shaoul Ezekiel); Human-Machine Systems in Manufacturing, Process Control, Transportation and Communication (Professor Thomas B. Sheridan); and So you Want to Build an Airplane (Professor Leon Trilling).

In Malaysia TDP is working with MUST to promote the education of individuals to carry out the social and industrial development of Malaysia and is employing several mechanisms including: long-distance learning techniques, teaching of short courses in Malaysia, and faculty and student exchange. TDP has focused its efforts on developing four graduate academic programs (Transportation Systems, Information Technology and Multimedia, System Design and Operation, and Chemical Process Engineering and Biochemical Process Engineering), during the coming years.

ORGANIZATION

The TDP Director is Professor Fred Moavenzadeh, Professor of Construction Management in the Department of Civil and Environmental Engineering. Professor Nazli Choucri of the Department of Political Science is the Program's Associate Director and Patricia Vargas is the Assistant Director.

Fred Moavenzadeh

DIRECTOR, LIBRARIES

Innovative initiatives have long been a hallmark of MIT's Libraries. From an early vision of a distributed system of discipline-oriented libraries, through the post-war futuristic ideals of Project INTREX, to the large-scale implementation of off-site storage in the 1970s, the Libraries have experimented with creative approaches to library and information service. In 1999–2000, the MIT Libraries took on a new challenge, that of defining library excellence for MIT in the 21st century.

The MIT Libraries fulfill an essential role in furthering MIT's mission of excellence in education and research. Underpinning the classroom, laboratory, and research center, the Libraries ensure that advances in knowledge and understanding are preserved and freely available to students and faculty—current and future. MIT has long recognized the richness of its Libraries' resources and the quality of their services. Indeed, both are understood as factors in the Institute's ability to attract and retain top-quality faculty and students.

Yet the defining characteristics of a world-class research library are no longer dictated solely by the strengths of 19th and 20th century libraries. Although the digital revolution is still a story in its earliest chapters, and there remains a serious disconnect between the hyperbole of digital champions and the experience of real students and faculty at MIT (and elsewhere), the systematic growth of networked electronic resources has begun to have an impact on teaching, research, and scholarship at the Institute.

This impact is, as yet, suggestive rather than transforming. At present, the potential of electronic publication resides largely in the enhanced speed and expanded geographic reach of current publications of limited length. Traditional library, archival, and publishing practices still continue to satisfy a significant majority of MIT's current information requirements, and ubiquitous networked access is but one of many obstacles to realizing the full potential of networked resources. Nevertheless, the digital environment provides opportunities for steady movement toward new modes of interaction between the MIT Libraries and the Institute's faculty and students. As on-going possibilities for improvement are identified, the Libraries will continue to seize those that have relevance to the research and educational mission of MIT.

CURRENT TRENDS

Three trends emerged in 1999–2000. First, for those disciplines where the Libraries have been able to introduce a critical mass of full-text networked digital resources, faculty and students are taking full, eager advantage of the flexibility provided. Second, our progress in redefining network-based service options has been enthusiastically welcomed by the MIT community. Usability testing, surveys of students and faculty, self-service alternatives, and network outreach strategies are among the tools employed during the past year to develop or refine an array of services that are responsive to faculty and student requirements. Third, the Libraries' close working relationships with Information Systems and the MIT Press continue to increase understanding and synergism among these important groups, and has resulted in improved service to the MIT community.

One consequence of these trends has been diverging expectations within the MIT community about the shape of library resources and services. For example, some faculty and students would have the MIT Libraries abandon print altogether, while others are deeply dismayed by the limited content, volatility, inadequate interfaces, and high cost of digital publications. Another example of diverging expectations is found in attitudes about the Libraries facilities. One faculty member will articulate the value of having many conveniently located traditional library facilities, while another chafes against the inconvenience caused by fragmenting the Institute's wealth of resources across multiple on-site and off-site locations.

This is also a time when long-standing legal and operational assumptions about library resources are increasingly in question. Faculty are disconcerted to find that their traditional right to make fair use of copyrighted library material is permissible on-campus, but forbidden in distance education. They are concerned that permanent ownership, which is assured with print collections, has no parallel in the license agreements that make digital resources available to the MIT community. Many faculty are aware that the digital environment itself includes no guarantees concerning the long-term viability of electronic formats, especially as compared to paper. And those who rely on the Libraries' off-site collections have begun to question the cost and effectiveness of placing 25% (and rising) of research resources in off-site shelving.

Cumulatively, these issues raise fundamental questions about the shape of MIT's Libraries in the future. While there are no easy resolutions to any of these conundrums, what is certain is that distinctions must be drawn and choices

must be made. During 1999–2000, the MIT Libraries turned to a strategic planning process to provide structured guidance for these choices.

STRATEGIC PLAN

The Libraries' Strategic Plan focuses on three broad directions that are critical to the future of the MIT Libraries. Combined, these strategic directions advance the Libraries' mission to be creative partners in the research and learning process at MIT, and comprise a Libraries' vision for resources, service, place, and technology. The directions are to:

- Excel at providing rapid, easy, and precise access to high quality information for education and research at MIT;
- Ensure that MIT Libraries' spaces and operations facilitate intellectual life on campus; and
- Be a leader among academic research institutions in the use of applied library technology.

Progress toward each of these three strategic directions during 1999–2000 is discussed in greater detail below.

To excel at providing rapid, easy, and precise access to high quality information for education and research

Locating and accessing accurate information has become increasingly difficult for faculty and students in today's many-media environment. The challenge to the Libraries is to provide user-friendly, integrated, responsive, and precise access to all resources, in any medium, in all relevant disciplines, wherever and whenever it is needed. No small task, to be sure. Taken broadly, this requires the libraries to develop service strategies, collection management practices, acquisitions policies, and system tools to better organize and merge an invaluable traditional Institute asset (the incomparable, still-growing physical collections) with emerging forms of research communication and educational instruction.

In furtherance of this strategic direction, in 1999–2000, the Libraries undertook a number of important initiatives. Among the more visible activities was the project to redesign the Libraries' web site as an information portal. Released thus far are "Vera: the Virtual Electronic Resources Access" web page; new and updated subject web pages designed to support academic disciplines, research interests, and specific courses at the Institute; and a variety of library instruction and orientation program content. Another highly visible project was the work within Document Services to make MIT theses available electronically. More than 4,000 titles are currently available, with more being added on a regular basis. Yet another interesting project was the second phase of a pilot project to offer electronic reserves, which was successfully concluded in June.

Three major projects to improve bibliographic access to the Libraries' traditional resources were launched or continued under this strategic direction during 1999–2000. First, success was achieved in improving the visibility and accessibility of government documents in the MIT Libraries collections. Second, significant progress was made in the cataloging of maps and other special format materials so these materials would be visible in the Barton online catalog. And, third, Collections Services successfully completed the second year of a highly creative, multi-year project to provide online bibliographic access to the MIT Libraries' extraordinary early research collections. Another area of service growth was interlibrary borrowing. Borrowing material and obtaining photocopies from other libraries to meet the needs of MIT faculty and students rose again during 1999–2000, reflecting a continuous upward trend (33% since 1995–1996) in this information service. The steady increase in demand has two bases. First, increased usage (and increased numbers) of electronic indexes and abstracts now allow faculty and students to identify additional materials relevant to their research. Not all of the references cited in these databases will be available within MIT's collections. Second, the rapid growth of research in health sciences-related disciplines is not mirrored in the MIT Libraries' collections. Research and teaching needs must often be met through interlibrary borrowing.

The Libraries also celebrated dramatic progress in expanding access to digital resources over the campus network. As of year end, over 1,300 journals and more than 200 databases were available on the network in support of MIT education and research.

To ensure that MIT Libraries' spaces and operations facilitate intellectual life on campus

For the foreseeable future, the Libraries' facilities will continue to play an essential role in MIT's learning environment and community spaces. Students look to the Libraries for support that contributes to their quality of life, collegiality, and intellectual growth. The Libraries must create spaces that meet the needs of today's MIT community—as well as their own operational needs. Students and faculty alike look to the Libraries to provide

places to think and write, to study and learn, to be a source for information and research materials, and a place where people are ready and willing to help in the use of those materials.

During 1999–2000, to advance this strategic priority, the firm of Shepley Bulfinch Richardson and Abbott was retained to assist the Libraries in an appraisal of library facilities needs and opportunities. As a consequence of this systematic planning process, two urgent building projects were identified, proposed, and funded for the fiscal year 2000–2001. A master plan for the MIT Libraries is scheduled for completion in late summer of 2000.

Also during 1999–2000, the Aeronautics/Astronautics Library moved to newly renovated quarters, where it will be an integral part of the Department's new state-of-the-art teaching laboratory.

Finally, a substantive review of the Libraries' Special Collections was completed to lay the groundwork for a series of discussions and recommendations regarding the stewardship of these resources, and their role in the intellectual life of the campus.

To be a leader among academic research institutions in the use of applied library technology
Information technology has had a dramatic impact on expectations regarding the definition and scope of libraries. Perhaps nowhere are these expectations more explicit than in a major, technically-oriented teaching and research institution like MIT. Unfortunately, both nationally and at MIT, the gap between expectations and reality is vast. There is a great need for library laboratories where the technical/social/economic impacts of proposed solutions can be reasonably assessed. MIT and its Libraries have a unique responsibility for the development of sustainable information technology models for the future.

During 1999–2000 the MIT Libraries undertook three major projects under the auspices of this strategic priority. The first of these projects is DSpace, a partnership of Hewlett-Packard Laboratories and the MIT Libraries. DSpace is a digital repository designed to provide a durable repository of documents that MIT faculty and researchers expect to share within the Institute and with their colleagues around the world. In a separate but related research initiative funded by the Andrew W. Mellon Foundation, the Libraries will design a business model to sustain DSpace when research funding is no longer available.

The second major applied technology project undertaken during 1999–2000 was that of upgrading the Libraries' library management system. Planning for the next-generation system began in 1998–1999, and the process of selecting a new system continued in 1999–2000 under the leadership of a small but broad-based and highly effective Libraries' task force. Implementation of the new system will require substantial effort in 2000–2001.

The third initiative was multi-faceted and responded to the MIT community's interest in more "self-service" options. A proxy server was brought online early in the academic year to enable qualified students and faculty to access many of the MIT Libraries' electronic subscription services from off-campus. Additional electronic databases and journals are being added, as contracts are revised, to provide this enhanced level of service to the community. A second "self-service" option being actively pursued is the Libraries' early participation in wireless infrastructure projects developed for the campus. The Libraries anticipate a high value in this functionality for students and faculty who carry web-accessible portable devices.

CONCLUSION

At the end of the day, the success of the strategic plan will be measured by two standards. First, success will be found in the eagerness with which the MIT Libraries' staff rises to the challenges it presents. The directions it describes are not simple nor are the solutions obvious. Moreover, none of these directions can be accomplished without active involvement on the part of the faculty and students of MIT. It will take courage to question assumptions and depart from the comfort of well-established service models.

The second measure of success will be in the MIT Libraries' ability to provide sustained, high value to the students and faculty of MIT. If the plan is successful, access to resources (including the extraordinary staff of the MIT Libraries) will be simplified and improved, fragmentation will be reduced, Libraries' spaces will facilitate intellectual life on (and off) campus, and technology will be developed and/or deployed in useful, sustainable, inventive ways.

To achieve the goals of the strategic plan the Libraries must work within the umbrella of the Institute's master planning process to develop a long-range facilities plan for the MIT Libraries. The Libraries must ensure that staff

are appropriately trained in new technologies and competencies, and that library organizational structures support their work. Finally, the Libraries must work closely with the Institute's academic leadership, Resource Development, the Council on Educational Technology, Information Systems, and many other academic and administrative leaders on campus to identify potential partners and supporters for library initiatives. The Libraries' success in meeting our goals within the "Campaign for MIT" will obviously be significant.

No report of this nature is complete without acknowledging the extraordinary efforts and commitment of the staff of the MIT Libraries. These exceptional individuals continue to exhibit an energy and enthusiasm that are the envy of our peers, and daily earn the respect and admiration of MIT's world-class faculty and students. The fact that many important projects and significant contributions cannot be singled out for attention in this document is no reflection on their significance to the Libraries or their importance to the work of the Institute. The MIT Libraries are equally grateful for the generous support they continue to receive from our academic and administrative colleagues here at MIT.

More information about the MIT Libraries can be found on the World Wide Web at http://libraries.mit.edu/.

Ann J. Wolpert

PUBLIC SERVICES

The MIT Libraries exist to support education and research at MIT. To do this successfully in an era of changing expectations, library services must evolve to retain the best of the traditional models while adding new approaches that expand and enhance access. During 1999–2000, the Public Services units of the MIT Libraries continued their review and evaluation of existing programs and undertook several pilot projects to inform our planning for future years. In the course of the year, we reaffirmed the essential roles libraries play in providing an array of information resources; different levels of assistance depending on the needs of the user; and conveniently-located, well-equipped spaces that are conducive to study, collaboration, and social interaction.

NEW STRATEGIC PLAN

The completion of a new strategic plan for the MIT Libraries in November 1999 endowed us with a structure and focus for Public Services initiatives already underway and in the planning stages. Significant progress was made in meeting the three strategic directions articulated in the plan: to excel at providing rapid, easy, and precise access to high quality information for education and research at MIT; to ensure that library spaces and operations facilitate intellectual life on campus; and to be a leader among academic research institutions in the use of applied library technology.

To pursue these strategic directions with confidence, this year Public Services staff created a number of survey instruments to help us gain keener insight into the needs of our user communities. We wanted to know: How do students, faculty and staff find and use information, and what impact has the availability of electronic journals and books had on their information seeking? Building on a comprehensive survey of undergraduate and graduate students carried out two years ago. Libraries' staff conducted several new surveys, including a major survey of faculty library and information usage. Twenty-seven percent of faculty responded to the questionnaire mailed to them. Their answers have provided us with much-needed data about the ways they use library resources, facilities, and services for research and teaching. Other surveys sought feedback on first-year students' need for instruction in the use of libraries and information resources and on satisfaction levels with the Libraries' document delivery programs.

Providing Rapid, Easy, and Precise Access to High Quality Information for Education and Research

Beyond the work done to build collections and license electronic resources for use by the MIT community described in the Collection Services section of this report, Public Services staff made additional significant contributions to help library users find services and information. One of the most important projects currently underway is a complete redesign of the MIT Libraries' web site. Launched in February 1999, this project has placed a heavy emphasis on usability throughout. Users were observed while interacting with our web site, enabling staff to better understand their conceptions of our services, collections, and virtual space. Feedback from our users allowed us to gradually create a structure that site visitors should find both logical and intuitive, a bridge rather than a barrier to their information seeking. Next the redesign team will work with a graphic designer to give form to this logical structure. The new site will be presented for review and comment in Fall 2000, and we expect the site to be finalized early in 2001.

Public Services staff spearheaded another project to make it easier to find electronic journals and databases. Early in 2000 the Libraries announced the creation of the "Vera: Virtual Electronic Resource Access" web page. Prominently listed on the MIT Libraries' homepage, it provides subject listings and links to licensed and unlicensed electronic resources that have been selected for the MIT community. A significant amount of work was invested in designing Vera so that it would be simple for students and faculty to use and straightforward for staff to update and maintain. To date Vera has proved to be a heavily used resource to help users navigate our growing collection of electronic information. One recent user sent this reaction: "Did I mention that I think this whole VERA thing is the greatest?" While not so high-profile as either the web site redesign or the Vera project, an effort to ensure the ongoing viability of pages on the web was another key initiative. Public Services staff invested a substantial amount of time in creating and updating subject web pages that correspond to disciplines, specific courses, or research interests at MIT. This type of work has become increasingly important over the past few years as students and faculty have begun to turn to the web as their first source of information.

Another technology-based project that continued this year was the effort by Document Services to make MIT theses available electronically. In a service formally launched in November 1999, we have sent more than 600 MIT theses to requesters on campus and all over the world via electronic delivery. There are more than 4,000 titles currently available, and more are being added on a regular basis. Because the MIT Libraries are highly regarded for the leadership role we have played in the development of electronic thesis delivery, we were invited to join the Networked Digital Library of Theses and Dissertations (NDLTD). The addition of MIT as a member of the NDLTD enhanced the stature of that organization and will facilitate cooperation in the development of techniques to distribute theses electronically. Membership in the NDLTD promises to present opportunities for MIT to share in future developments in electronic thesis delivery.

Libraries' staff also continued to collaborate with I/S on a discovery project on electronic reserves. Four classes made use of the fledgling e-reserves service, one of the classes offering MP3 audio files in addition to scanned articles. In their evaluations of the e-reserves pilot, students in all four classes overwhelmingly responded that they would recommend e-reserves to other students. A report containing cost projections and staffing recommendations has been written and forwarded to the Libraries' administration and I/S. A decision will be made early in 2000–2001 about future growth of the e-reserves service.

This year Public Services units have also devoted attention to developing their instruction and orientation programs in new directions. A team of librarians finished a videotaped orientation that featured the MIT mascot in an X-Files style mystery that provided a vehicle for showcasing the MIT Libraries and some basic resources. The video, shown on MIT cable and in a number of other venues during the fall orientation, was deemed "pretty cool" by students in one of the dorms. Later in the fall the video was made available to the general public through the Libraries' web site.

Not all Public Services projects are so technology-intensive. This year staff increased their efforts in the areas of more traditional forms of instruction and outreach. Among the most innovative approaches was the tremendously successful InfoFair hosted by Dewey Library staff to promote MIT Libraries services to user communities at the east end of campus. People who stopped by the InfoFair booth on the plaza in front of the Hermann Building were given free items that provided information about library services and/or about library-supported databases. The entire Dewey staff participated, and more than 200 people attended this one event.

One last undertaking that will undoubtedly result in a number of changes was the work of a small task force to develop a report and recommendations on delivery of materials to members of the MIT community. This group studied the current mechanisms in place for physical and electronic delivery of items owned by the MIT Libraries as well as items we obtain from other libraries and vendors to supplement our collections. At present this work is handled by several different units, so it can be difficult for users to figure out which place to contact. Using the recommendations in the report, during 2000–2001 we intend to simplify and streamline the process for requesting materials and hope to make this much more intuitive for our users.

Ensuring that Library Spaces and Operations Facilitate Intellectual Life on Campus

The past year brought much planning and significant change in a number of library spaces:

- After years of planning, the Aeronautics/Astronautics Library moved to a new location, designed to be an integral part of the new Aero/Astro teaching laboratory. Although much smaller in square footage than its former location, this new facility represents an innovative design which will allow the library to continue to provide the excellent services and collections to which faculty and students have become accustomed.

- In the Barker Engineering Library, work began to restore the original terrazzo flooring of the grand reading room under the Great Dome. New signage was installed both in Barker and in Lobby 10 directing users to Barker and the photocopiers were moved in order to create space for much-needed additional workstations to access digital resources. Lastly, in response to student requests, planning has begun to convert a large storage closet into a group study space.
- Dewey Library staff undertook a major space planning project. In gathering ideas from Dewey clientele, the most serious issues identified were physical plant/facilities problems, the need for more net drops, a desire for more comfortable seating and furniture, and demand for better study spaces. A three-year space improvement plan was developed, in which each of these concerns was addressed. Study furniture on the first floor is slated to be replaced in 2000–2001, space on the second floor is being emptied in order to create several group study rooms, closer relationships have been established with the Facilities Department team leader so that building problems are attended to more speedily, and IS has installed additional net drops and electrical outlets.
- The public computing area in the Humanities Library was reorganized to maximize privacy and convenient access to printers. The staff have also collaborated with the Writing Center staff in planning for a Writing Resource Reference Area.
- New furniture was ordered and installed in the Institute Archives and Special Collections Reading Room to make the public space more useable and to increase security for the collections being used by researchers.
- The Science Library received approval for a project to renovate the entrance to the Science Library and to create a study space that can be open around the clock. More detailed planning for this project, which includes compact shelving for the basement of Building 14, has begun, and physical construction is expected to begin in late Spring 2001.

Besides planning for space changes, the Libraries succeeded in beginning or continuing several other initiatives to enhance intellectual life at MIT. One ongoing, very popular activity is the *authors@mit* series, a collaborative effort of the Libraries and the MIT Press Bookstore to bring noted authors with MIT connections to speak at events held in one of the Libraries or elsewhere at MIT. Another program that has received much positive attention is "The Object of the Month" exhibit posted by Institute Archives staff. Each month an archival or manuscript collection object such as a letter, a page of print text, or a visual image, is chosen from one of the Archives' collections and featured in both a small exhibit case outside the Archives and on the Archives' web page at http://libraries.mit.edu/archives/.

Leading in the Use of Applied Library Technology

In recent months a number of Public Services librarians have studied web-based customer service technology in use in the retail sector and have begun to think about how this technology might be applied to library services. There is a growing sense of urgency about this because library staff are well aware that students and faculty are increasingly likely to turn to the web to find information they need, often from offices and dorms that do not give them the capability of interacting with professional librarians for direction. As a first step in figuring out how to deliver remote information and reference services, a small group of librarians has written a proposal for a digital reference project that would allow reference providers to interact with users as they search the web. We expect to experiment with commercial software during the next year and will be one of a handful of academic libraries that is actively trying to develop an innovative remote reference service.

The Libraries are also eager to pursue wireless technology in order to make it easier for library users to access the array of electronic resources we provide. Due to a relationship established this past year between the Dewey Library management team and the Sloan School I/T management group, Dewey has been slated to be the first divisional library to receive a wireless infrastructure as part of the Sloan School installation for wireless communications in all its facilities. We have also been involved in discussions about wireless deployment on the MIT campus in general and are optimistic that the Libraries' spaces will be among the first to provide this enhanced access.

ORGANIZATIONAL AND PERSONNEL-RELATED DEVELOPMENTS

Public Services units have continued their work of the past three years to change the organizational culture and structure to ensure that library services are responsive to the needs of the MIT community and change over time as technology and user demands require. One major development during 1999–2000 was the start-up of a series of committees that focus on specific segments of the Libraries' user population. The faculty survey described earlier in this report was adeptly carried out by the Faculty User Group. This group has already begun to advocate for improvements and changes in services for faculty. The Graduate Student User Group and the Alumni User Group have both established productive working relationships with key players in their constituencies, and plans are in place for closer collaboration on future programming. While groups focusing on service to administration, researchers and post-docs, undergraduate students, and outside users had just begun their work at the end of the

fiscal year, they also hold great promise for creating stronger ties, more cooperation, and better understanding of how the MIT Libraries can best serve the MIT community.

On the personnel front, the past year was one in which many units experienced serious problems in retaining staff. Across Public Services, 29% of the staff turned over. Particularly hard hit were the five divisional libraries and the Institute Archives. Staff left their positions for a number of reasons, including internal promotional opportunities, changes in careers, and competition from the for-profit sector. In some cases we filled in with temporary appointments, but even temporary help was hard to find and retain. It is clear that we cannot sustain this level of staff turnover in the future, so a high priority in 2000–2001 will be the development of strategies to improve retention.

On the positive side, we have been very fortunate to recruit exceptional staff to come to the MIT Libraries, and they join an outstanding group of colleagues already in place. Three new department heads [Catherine Friedman, Dewey Library; Steven Gass, Barker Engineering Library, and Megan Sniffin-Marinoff, Institute Archives (who became full-time in July 1999)] and three new associate heads (Elizabeth Andrews, Institute Archives; Patricia Flanagan, Dewey Library; Deborah Helman, Barker Engineering Library) were appointed. In addition to these positions, we filled 30 other slots covering both professional and support staff.

IN CONCLUSION

This report only skims the surface of the most visible and notable achievements of Public Services staff in 1999–2000. Given the difficulty experienced with staff turnover, the major progress that has been made on a number of fronts is even more impressive. The MIT Libraries have finished the year with stronger ties to members of the MIT community, and we are well-positioned to continue to grow and develop in the coming year.

Virginia Steel

COLLECTION SERVICES

During most of the 20th century, libraries were defined as buildings holding collections (along with staff who supported the use of those collections in many ways). At the beginning of the 21st century a shift in the very concept of libraries is evident. Libraries will be defined as a matrix of services that facilitate access to information from a broad variety of sources and in many formats. Library collections are becoming a mix of on-site collections, off-site collections, and digital resources. During 1999–2000, the Libraries' Collection Services staff were engaged in special projects and ongoing processes in support of each of these components of the Libraries' delivery of information resources to the MIT community.

ON-SITE COLLECTIONS

On-site collections will continue to be a core resource and unique asset for MIT students, faculty, and researchers. Collection Services continued our commitment to acquiring them, providing bibliographic access to them, and caring for them in numerous ways this year. Particular attention was directed to valuable collections which have been difficult to locate and use, but which can significantly expand the readily available information base.

Government Documents

The MIT Libraries have been a Depository Library for U.S. Government Documents since 1946. Through the Depository Program, the Libraries maintain approximately 6,000 subscriptions and acquire approximately 6,000 monographs a year. Due to staffing levels, however, up until now only a small percentage of these materials had records in Barton, the Libraries' online catalog. During 1999–2000, we moved to fill this access gap. A cross-departmental planning group, coordinated by the Collection Services Information Technology Librarian, planned processes for loading MARC (machine-readable cataloging) records for the monographs from an outside supplier, using software created at UC Riverside. Brief records will be loaded at the time of receipt of the documents. This step has been implemented (after significant cleanup of our existing documents database). Full bibliographic records will be overlaid on a continuous basis as they become available from the Government Printing Office. This step should be implemented by September 2000.

In addition to this project for machine-loading records for government document monographs, we began to deploy serials cataloging staff to an in-house effort to gradually add records for the subscription materials. Taken together, the effect of these two projects will make the Libraries' rich collections of government documents known to all users of the catalog. In addition to dramatically improving access to the materials, the project has also streamlined handling of government documents by several library units.

Maps and Other Special Formats

In July 1999, we filled a newly defined position in the Bibliographic Access Services department: Special Formats Cataloger. This position was created in recognition of the continuing expansion of our acquisition of formats other than print books and serials, and our insufficient capacity for providing catalog access to them. In the first year of the existence of this position, we have made significant progress toward our goal of effective bibliographic access for all formats of information. Records for the following special formats materials were added to Barton: maps and city plans in the Rotch Library, newly acquired maps in the Lindgren Library, the Anderson Award Projects in Rotch, and videos of architecture lectures held by Rotch and of CLSI and EECS lecture series held by Barker Engineering Library.

Rare Books Task Force

In September, the Libraries' Steering Committee received the report of the Special Collections Task Force. The report documented the significance of the Libraries' collections of rare books and their potential as scholarly resources. It called attention to the need for integrated solutions to significant problems of bibliographic and physical access, staffing, space, and security. By the end of 1999–2000, a position in Bibliographic Access Services had been designated as principally responsible for cataloging these collections, an important first step toward those "integrated solutions."

Two additional activities related to on-site collections this year were notable: the cancellation of serial titles amounting to 2% of our serials budget was carried out efficiently last summer to adjust for over-expenditure of the budget in 1998–1999; and collection development policy statements for 22 subjects were completed.

OFF-SITE COLLECTIONS

The continuing growth of the Libraries' physical collections and the growing space pressures on MIT's campus mandate that off-site collections will be a permanent component of the Libraries' strategy for providing access to information resources.

Space Planning

In order to achieve an acceptable balance between on-site and off-site collections, as well as to address many other pressing space issues within the Libraries, a master space planning project was conducted during 1999–2000. The report resulting from that process gives direction to interim short-term space projects, as well as to fundraising for capital projects that would relieve space pressures and provide appropriate library spaces for the 21st century. Two proposals to CRSP for space projects in 2000–2001 were approved. One of these, a proposal to install compact shelving in the basement of Hayden Library, will be an initial step toward slowing the movement of collections to off-site locations.

Storage

Fiscal year 2000 was the second year in a three-year project to accelerate our moves to storage in order to provide adequate on-site shelving for the remaining collections. Our goals at the beginning of the project were to move 25,000 to 30,000 volumes from the Science Library in year one, 20,000 volumes from the Humanities Library in year two, and 20,000 volumes from Barker Engineering Library in year three. After a slow start in year one, with only 3,000 volumes moved from the Science Library, we made up for lost time this year. An additional 22,000 volumes were moved from the Science Library, as well as 22,000 volumes from the Humanities Library. Barker Engineering Library has already begun the selection process for its moves in 2000–2001. In total this year, 72,000 volumes were sent to the Harvard Depository, comprising 30,000 volumes from the Libraries' on-site facilities and an additional 42,000 from the RetroSpective Collection (RSC). The moves from the RSC were required in order to make room for another 27,000 volumes from the on-site collections, for which closer proximity to the campus was considered desirable. In addition to the negative impact of disrupting the research process of library users, the movement of this significant volume of materials to storage is a labor-intensive activity for the Libraries, impacting almost every department. The tasks involved include selection, packing and moving, shifting materials remaining on shelves, bibliographic record changes, disposition of duplicates discovered in the process, and accelerated recalls and deliveries.

Retrospective Cataloging of the Early Research Collection

Fiscal year 2000 was also the second year of a multi-year project to provide bibliographic access to the so-called Dewey Decimal Collection, which is housed in the RSC. This collection contains some of the Libraries' oldest materials, with imprint dates ranging from 1780 to 1963. About 25,000 monograph titles have been cataloged by Online Computer Library Center (OCLC) on a contractual basis since the project began in June 1998, with an

estimated total of 65,000 titles in the collection. This year, the entire file of records created during the first year of the project was loaded into Barton, and daily loads of new records were implemented. Requests for these items are increasing as the records become visible and another of MIT Libraries' rich collections of resources is readily available to the Libraries' users. In addition to the project for outsourced cataloging of monographs in this collection, serials catalogers are keeping pace in an on-site project to catalog the serial collections. This year, approximately 450 serial titles were cataloged, making it possible to move 11,500 volumes to the Harvard Depository, while at the same time increasing their visibility and use.

Digital Resources

Dramatic progress was made this year in expanding the access to digital resources on MITnet. In April, the Libraries marked the milestones of the 1200th e-journal (*ScienceOnline*), and the 200th database (*Derwent Innovations Index*) with a public celebration. By the end of 1999–2000 the totals were 1,337 e-journals and 210 databases, in comparison to approximately 500 e-journals and 100 databases at the end of 1998–1999. Major additions this year included the following:

- Academic Ideal (all Academic Press journals)
- Blackwell Science (all journals)
- Project Muse (journals from many university presses)
- ScienceOnline
- Reference USA
- SDC Platinum (Global New Issues, VentureXpert, Mergers and Acquisitions)
- Digital National Security Archives
- ArdenOnline
- Marquis Who's Who
- Periodical Contents Index
- LION (Literature Online)
- Ulrich's International Periodicals
- ArtBibliographies Modern

We continued to develop our processes for managing the acquisitions and cataloging of digital resources, and our presentation of them to our library users.

Acquisitions Processes

The Digital Resources Acquisitions Librarian worked closely with the Libraries' Web Manager to develop Virtual Electronic Resource Access (Vera), a FileMaker Pro database that now facilitates management of every aspect of our digital resources acquisitions processes, as well as the presentation of digital resources on the Libraries' web site. Vera provides centralized record-keeping for all the acquisitions processes, including license restrictions, access control methods, URLs, technical contact information, contract renewal dates, and IP addresses. It has substantially improved—actually transformed—the way we manage digital resources. The implementation of a proxy server for off-campus access was another significant transition this year. The Digital Resources Acquisitions Librarian reviewed and renegotiated licenses to maximize the number of products we could deliver off-campus, totaling 79% of our databases and 94% of our e-journals at this point in time.

Cataloging Processes

Over 1,000 electronic journals were cataloged in 1999–2000, and approximately 400 electronic products were cataloged as monographs, more than doubling the numbers cataloged last year. Several large database packages include electronic monographs that are still queued for cataloging. There are many complexities still to be resolved in relation to cataloging digital resources. As an example, redesign of two large databases, after substantial cataloging had been done on the contents, required subsequent recataloging. At year end, the Libraries had engaged in a series of discussions related to the scope of materials to be included in our catalog and whether distinctions can be made among types and levels of records in order to provide timely access to more materials.

Catalogers completed their participation in OCLC's Cooperative Online Resource Catalog (CORC) pilot project, and began to investigate whether CORC could now be used operationally as a means of creating brief records for some electronic materials quickly and inexpensively. The Special Formats Cataloger, as part of an IS/Libraries Discovery Team, is investigating the possible extraction of Federal Geographic Data Committee (FGDC) metadata for building catalog records for Geographic Information Systems (GIS). Our continuing struggles with cataloging issues related to digital resources seems parallel to the uncertainties we faced two or three years ago related to

processes for acquiring them. We hope that over the next few years we will be able to construct solutions to the cataloging questions that are as satisfactory, and satisfying, as those we have devised for acquisitions processes.

A System for Managing All Collections

Integral to our management of all collections—on-site, off-site, and digital—is our library management system, currently Geac Advance. Several activities in 1999–2000 contributed to the thrust for continual improvement. In July and August, during the process of testing the Geac authorities loader, staff discovered critical problems with record matching. A software fix was contracted for with the vendor, who subsequently incorporated the changes in an upgrade for its entire customer base. In the early fall, daily vendor-based authorities processing was implemented, resulting in a continuing high level of heading consistency and references in the Libraries' catalog. We further strengthened our focus on the quality assurance of the database by redefining a support staff position as a MARC Database Quality Technician.

Led by the Third Barton Project Management Team, staff members in Collection Services were involved this year in several stages of the search process for our next library management system. Staff participated in reviewing and evaluating five vendor presentations in the fall of 1999. Following that, scenarios were created in each functional area to provide an evaluative methodology for more in-depth presentations by finalist vendors. In addition, many individual projects were launched in preparation for migration of the database. In the first decades of the 21st century, Collection Services will be continually challenged in our endeavors to manage collections in broadly varying formats, in a mix of physical and virtual locations. The staff will rely on and contribute to changing technologies that will support successful management. We will seek to preserve the best of our traditional values and practices, as we develop the flexibility, experimentation, and vision this new environment requires.

Carol Fleishauer

TECHNOLOGY PLANNING AND ADMINISTRATION

Facilitating our work through technology is no longer the responsibility of a single person or unit of the MIT Libraries. We have successfully moved to a model, which distributes that responsibility throughout the structure of our organization, always aiming to bring it closer to the sites where mission-critical work gets done. Our Information Technology Librarians have worked within both Public and Collection Services to ensure that we are aware of the opportunities technology affords and pursuing those most likely to serve the mission of the MIT Libraries. Our Systems Office not only professionally manages those systems central to MIT Libraries' services, but also works with a host of Local Technology Experts spread throughout the Libraries' departments to manage desktop computing problems at the source and distribute technical know-how into the capillaries of our organization. This extraordinary model of strategizing about and supporting technology has become for us in this last year the ordinary. Still, it takes no less work, commitment, and dedication from our staff both inside the Systems Office and around the Libraries. The fact is that this foundation of effort by Information Technology Librarians, Systems Office staff, and Local Technology Experts has given the MIT Libraries the ability to raise our heads and focus on new strategic opportunities.

DSPACE

Our most exciting new opportunity to harness technology for the MIT Libraries and the Institute presented itself during a conversation with visitors from Hewlett-Packard in August 1999. In the course of the conversation we found common ground and began to discuss opportunities for HP to work directly with the Libraries on a project of mutual interest. Within two weeks we had drafted the project plan that would, many months later, be introduced to the world as the DSpace Project.

DSpace is a digital repository being designed to house those documents which MIT faculty and researchers are prepared to share with their colleagues around the world. HP has granted MIT $1.8 million to conduct the research necessary to build DSpace while also contributing some of its own staff both directly to the project and in support roles from HP facilities. The Andrew W. Mellon Foundation provided $215,000 of grant funding for a related project to design a business model to sustain us after the HP funding runs out at the end of 2001.

A Steering Committee of HP and MIT staff has already met and will continue to meet to ensure the project stays on track. An Advisory Committee of MIT faculty and Libraries' staff will begin to meet soon to make sure the project is properly positioned within the MIT environment. Already on the DSpace team are two HP employees and two MIT employees, with at least three more staff members to be hired. The DSpace staff have moved into a renovated office in the Barker Engineering Library where they have begun the work of building DSpace itself.

Our announcement of the project was noted in much of the academic and library press. A briefing on DSpace at the Coalition for Networked Information spring task force meeting also helped make the academic community aware of our effort. We have already been contacted by many institutions interested in sharing their knowledge of this domain with us, learning from us, or possibly using the DSpace model on their campus once we have it built. Our timeline calls for an early prototype by the end of 2000 with version 1.0 ready for use by the faculty and researchers of the Institute in Fall 2001.

In addition to being an exciting project in its own right, the DSpace project also serves as a model of the kind of work the MIT Libraries would like to engage in. Our Strategic Plan calls for establishing a "library laboratory" to explore those areas where the MIT Libraries could lead in the appropriate adoption of technology. DSpace is teaching us what we need to learn so that we can work effectively with corporate partners, establish a place for some of our staff to focus on the future, and gain confidence in our ability to articulate fresh visions for the Institute community.

THIRD BARTON

While establishing new services and coming to terms with the future role of libraries at MIT, we still must attend to our core business: managing the assets of the Institute with which we have been entrusted. Much of that management is done via our library management system, known on campus by the name Barton. Our current Barton software system has come to the end of its useful life. Planning for the next-generation system began in 1998–1999 and the process of selecting a new system, the third generation of Barton, continued in 1999–2000.

During this year the "Third Barton Project" met its timeline, inviting five vendors to campus for day-long demonstrations in front of MIT staff and then narrowing this pool down to two final contenders. An RFP was issued to those two candidate vendors (a company called Sirsi, which sells the Unicorn system, and Ex Libris, which sells the Aleph500 system). The Third Barton Project Management Team and the rest of our staff did a great deal of work preparing scenarios these vendors will use during a week-long visit later this summer. We expect to select a vendor and negotiate a contract during Fall 2000 and bring the new library management system up at the end of 2000–2001.

The MIT Libraries would like to acknowledge the support received for this project from the Office of the Provost, the IS Department, and the Finance Department. Their assistance is crucial to the implementation of the Third Barton system.

MEETING CUSTOMER EXPECTATIONS

Responding to the urging of faculty and students who needed access to electronic resources from off-campus, the Libraries began running a "proxy" server in August 1999. While the campus architecture favors certificates as a means of authentication rather than network address, many vendors of information resources depend on identifying legitimate users by the Internet address of their browser. By running a proxy server, the Libraries are now able to check the web certificates of a user and pass legitimate users on to vendors as though they were operating their browser from an on-campus machine.

The MIT Libraries also began testing self-service circulation during the last year. Although installation of a pilot "self-check" system proved difficult, we were able to set up a self-check station in the Hayden Library building. Self-service is an expectation our customers are expressing, and this pilot project will test actual customer behavior.

LEVERAGING THE CAMPUS I/T ARCHITECTURE

This year the Libraries began to use the Data Warehouse to keep critical customer information (our patron files) up-to-date. Close alignment with Data Warehouse information should ensure that our records recognize members of the MIT community without additional fuss or bother.

The Libraries have also enjoyed representation on the new I/T Architecture Group that has grown from the work of the Integration Team over the past year. This intimate connection to the Institute-wide strategizing on issues of information technology has helped the Libraries plan effectively for the future while contributing a broader perspective to the work of the Group.

The Libraries successfully made the case that our common spaces should be part of any wireless infrastructure rollout on campus. While this infrastructure has not actually been installed yet, we are pleased that the role of the Libraries was clearly enough understood that our spaces will be covered even if a more modest rollout is eventually

agreed to. It is vital that the Libraries continue to be a central part of the Institute's information technology infrastructure.

YEAR 2000

The Y2K transition was so smooth that it is easy to forget that it was accomplished during this fiscal year. Within the MIT Libraries we made a conscious effort not to overreact to the hype so pervasive in the last six months of 1999. Staff in our Systems Office took sensible precautions with our central systems, such as Barton, and made sure that the rest of our staff understood how to minimize their exposure to potential Y2K bugs. But we did not, as a rule, spend very much time planning for the fall of civilization. Instead we prepared to fix what broke and clean up any resulting mess. The fact that very little broke vindicated this strategy—a strategy which made it possible to spend energies on other opportunities.

NEW COLLABORATIONS

Partly due to the minimal time spent on Y2K prep, we were able to forge a new relationship with the MIT Press to collect three of their electronic journals. This small project, which allowed the Press to increase reader and author confidence in their journals and allowed us to get to know some of the problems inherent in mounting a collection of this sort of material, might not have been possible if we had spent our energies less judiciously. The project with the Press leaves us plenty of room to grow, especially since archiving electronic journals is now a hot topic of interest to both academic libraries and the publishing world.

PLANS

Both the Third Barton and the DSpace projects will demand an enormous amount of effort from us in the coming year. Even more exciting, though, is the fact that our exploration of appropriate technologies for the Libraries will be conducted well beyond the bounds of our Systems staff. For example, our Public Services staff will be exploring tools for digital reference services, while Collection Services staff will investigate ways to enhance the navigation we offer customers through our electronic resources. This work will be facilitated by our excellent Systems Office, including a new programmer there, but the ideas and initiative are coming from the whole staff. Just as they should.

Eric Celeste

MIT PRESS

We have had an extraordinarily good year overall for fiscal year 2000, our second consecutive year of record surpluses. We have exceeded expectations this year in several categories.

Domestic book sales were up about 8%, with continuing strong performance from the back list. We are especially pleased with export sales, particularly in light of the discontinuance of our export mark-up. Traditionally, except for some special textbook pricing, our prices have been marked up about 30% for export markets. We eliminated that mark-up in January in response to pressure from foreign booksellers who were finding it increasingly difficult to cope with Internet booksellers who were offering their customers U.S. prices on our books. Our strategy to compensate for this change was to raise prices on our back list and to hope for offsetting increased unit sales. It worked. Sales improved in UK/Europe about 6% and in Canada about 12%. Total export sales were up 4.2%.

Domestic textbook sales were up 18% over last year, and sales of books from our website increased from $214K in 1998–1999 to $329,000 in fiscal year 2000. Journals sales were also up. Despite major glitches in migrating to a new fulfillment management system, Journals produced a net surplus of $310,000. We also put the finishing touches on CogNet, which was officially launched at the annual ALA meeting in Chicago in July 2000. Our contract for ArchNet has been renewed for another year by the Aga Kahn Foundation, and the Press worked with the MIT Architecture Department to win a developmental grant from the iCampus for the first two years of the development of M.ArchNet.

We have also made serious strides in the development of our new warehouse fulfillment operation in collaboration with the university presses at Harvard and Yale. All three Presses will be fulfilling orders from the warehouse by the end of fiscal year 2001.

The front list continues to grow. Sales of new titles were up about 7%, from $6241K to $6671K. We also put into place a promising list for fiscal year 2001. New list growth may slow somewhat in fiscal year 2002–03 because we have recently lost four important members of the Acquisition's team. We have been very fortunate in quickly filling

two of these four slots with seasoned editors who have hit the ground running. We expect to fill the second slot in economics and finance, and the slot in neuroscience, within the next few months.

While the smash hit of the year was *Mapping Boston*, the top 20 titles for the year reflected the full range of our core programs. It is noteworthy that we had a good sales performance year even in the face of record returns, particularly in May and June. Overall, our returns were at 22% of sales in fiscal year 2000 compared to 18% in fiscal year1999.

Our reference book program continues to produce one major offering each season, notable recent successes being *The MIT Encyclopedia of The Cognitive Sciences*, and *The New Cognitive Neurosciences.*

The Journals division continues to make advances in sales and in developing partnerships for electronic asset management. The most significant connections this past year were partnerships with Project Muse, Catchword, and Highwire. The Journals division has also been instrumental in developing the marketing program for the launch of CogNet, in preparation for taking over management of this program in fiscal year 2001.

The staff of the Digital Projects Lab has been increased from four to six with the addition of two programmers, and the group has moved to new quarters in 3 Cambridge Center. One programmer will be devoted entirely to the support of journals, primarily developing web-enabled sites for individual titles. The DPL is also responsible for the technical development and support of CogNet, the development and management of ArchNet for the Aga Kahn Foundation, and the implementation of the design and functionality of M.ArchNet (in collaboration with the Department of Architecture). The DPL is also responsible for continuing technical support for our website and electronic catalogue, which will migrate to an Oracle database and new server during the coming year. The new configuration will allow for sophisticated e-commerce transactions on the site as well as developing targeted services for our customers.

We have also made significant strides in developing a strategy for overall electronic asset management and have implemented a number of partnerships with e-content accumulators such as NetLibrary, Books 24x7, GlassBooks, eBrary, and R.R.Donnely, and we are currently exploring other vendors such as Questia.

Editorial, Production, and Design continue to increase throughput for our growing list while maintaining our traditionally high standards. We are currently reconfiguring office space to accommodate additions to staff in all three departments to accommodate the growing list.

Our balance sheet has improved as we continue to pay down the negative reserve accumulated from RATA charges. That figure was $1.5 million at the end of fiscal year1998, $1.2 million at the end of fiscal year1999, and will be about $700,000 for fiscal year 2000. We are on target for eliminating it by the end of fiscal year 2002.

MIT authors:
Anderson, *Peter Behrens and a New Architecture for the 20th Century*
Brooks, *Cambrian Intelligence*
Cassell et al., eds.,*Embodied Conversational Agents*
Diamond, ed., *Issues in Privatizing Social Security*
Edgerton, *Exploring the Art and Science of Stopping Time (CD-ROM)*
Evans & Schmalensee, *Paying with Plastic*
Garfinkel, *Architects of the Information Society*
Kindleberger, *Comparative Political Economy*
Laffont & Tirole, *Competition in Telecommunications*
Lim, *Technology and Productivity*
Mitchell, *e-topia*
Shutkin, *The Land That Could Be*

Among the noteworthy books by non-MIT people from our scholarly and professional program were:
Allen & Gale, *Comparing Financial Systems*
Arms, *Digital Libraries*
Baldwin & Clarke, *Design Rules, vol. 1*
Bazerman, *The Languages of Edison's Light*
Bloom, *How Children Learn the Meanings of Words*
Borgmann , *From Gutenberg to the Global Information Infrastructure*
Bradford, *Taxation, Wealth, and Saving*
Buchanan & Musgrave, *Public Finance and Public Choice*
Camp, *Trust and Risk in Internet Commerce*

Casati & Varzi, *Parts and Places*
Clements & Hendry, *Forecasting Non-stationary Economic Time Series*
Cziko, *The Things We Do*
DeSombre, *Domestic Sources of International Environmental Policy*
Dolev, *Self-Stabilization*
Fletcher, *Disappearing Acts*
Forrester, *The Deliberative Practitioner*
Fox, *Economy and Semantic Interpretation*
Freed, *Neural Transplantation*
Garber, *Famous First Bubbles*
Garcia-Johnson, *Exporting Environmentalism*
Gazzaniga, ed., *The New Cognitive Neurosciences*
Gisolfi & Mora, *The Hot Brain*
Gompers & Lerner, *The Venture Capital Cycle*
Hamilton & Viscusi, *Calculating Risks?*
Hardcastle, *The Myth of Pain*
Juarrero, *Dynamics in Action*
Klahr, *Exploring Science*
Lafont, *The Linguistic Turn in Hermeneutic Philosophy*
Levinson, *Presumptive Meanings*
Lindert, *Shifting Ground*
Ludlow, *Semantics, Tense, and Time*
Mandelbaum, *Open Moral Communities*
Metzger & Wen, *Automatic Algorithm Recognition and Replacement*
Neidle et al., *The Syntax of American Sign Language*
Newbery, *Privatization, Restructuring, and Regulation of Network Utilities*
O'Brien, *Making Better Environmental Decisions*
O'Neill, *Waste Trading among Rich Nations*
Schreiber et al., *Knowledge Engineering and Management*
Segal, *A Slim Book about Narrow Content*
Shubik, *The Theory of Money and Financial Institutions*
Steedman, *The Syntactic Process*
Stephens & Graham, *When Self-Consciousness Breaks*
Stone, *Layered Learning in Multiagent Systems*
Subrahmanian et al., *Heterogeneous Agent Systems*
Svenonius, *The Intellectual Foundation of Information Organization*
Thornton, *Truth from Trash*
Vives,*Oligopoly Pricing*

New hardcover books for trade and general audiences included:
Ben-Ze'ev, *The Subtlety of Emotions*
Bowker & Star, *Sorting Things Out*
Buck-Morss, *Dreamworld and Catastrophe*
Calvin & Bickerton, *Lingua ex Machine*
Crary, *Suspensions of Perception*
Cuff, *The Provisional City*
Easterling, *Organization Space*
Finkelpearl, *Dialogues in Public Art*
Graham, *Two-Way Mirror Power*
Hughes, *Sensory Exotica*
Kahn, *Noise, Water, Meat*
Krieger & Cobb, eds., *Mapping Boston*
Laporte, *History of Shit*
Lee, *Object to Be Destroyed*
Lerup, *After the City*
Lunenfeld, *Snap to Grid*
Morton, *Hybrid Modernities*
Pacey, *Meaning in Technology*
Pesic, *Labyrinth*
Reiss, *From Margin to Center*
Shleifer & Treisman, *Without a Map*
Sichel, *Germaine Krull*
Smil, *Feeding the World*
Stafford, *Visual Analogy*
Stefik, *The Internet Edge*
Thornhill & Palmer, *A Natural History of Rape*
Thornton, *Pandora's Poison*
Ubel, *Pricing Life*

Books published primarily as texts included:
Brook & Stainton, *Knowledge and Mind*
Chierchia & McConnell-Ginet, *Meaning & Grammar, 2nd ed.*
Goudie, *Human Impact on the Natural Environment, 5th ed.*
Kennedy, *Macroeconomic Essentials, 2nd ed.*
Lasnik, *Syntactic Structures Revisited*
Manning & Schütze, *Foundations of Statistical Natural Language Processing*
Margulis et al., eds., *Environmental Evolution, 2nd ed.*
Pissarides, *Equilibrium Unemployment Theory, 2nd ed.*
Turnovsky, *Methods of Macroeconomic Dynamics, 2nd ed.*
Weisler & Milekic, *Theory of Language*
Westland & Clark, *Global Electronic Commerce*

Editors in the Acquisitions Department included: Laurence Cohen (Editor-in-chief; Social Theory, Science & Technology Studies); Amy Brand (Psychology and Linguistics); Roger Conover (Art and Architecture); Clay Morgan (Environmental Studies); Robert Prior and Douglas Sery (Computer Science); Victoria Richardson (Finance); Michael Rutter (Neuroscience); and Terry Vaughn (Economics).

TITLES (in order of contribution to overhead)

HARDCOVER

Corman, *Intro to Algorithms*
Gazzaniga, *New Cognitive Neurosciences*
Krieger, *Mapping Boston*
Benninga, *Financial Modeling*
Thornhill, *The Natural History of Rape*
Gompers,*Venture Capital*
Wilson, *The MIT Encyclopedia of Cognitive Science*
Westland, *Global Electronics*
Manning, *Statistics of Natural Language*
Mitchell, *e-topia*

PAPERBACK

Boulanger, *The CSound Book*
Adams, *Beginning to Read*
Austin, *Zen and The Brain*
Kennedy, *Guide to Economics 4th Ed.*
Norman, *The Invisible Computer*
Akmajian, *Intro to Linguistics 4th Ed.*
Sterling, *How to Build A Beowulf*
Rice, *Inverted Odysseys*
Krugman, *Pop Internationalism*
Cormen, *Intro To Algorithms*

Table 1. Comparative Operating Results (In Thousands)

	FY00	FY99	FY98
Total Net Book Sales	18,029	16,776	15,469
Cost Of Sales	8,039	7,390	6,932
Gross Margin on Sales	9,990	9,386	8,537
Other Pub. Income	182	178	193
Bookstore Net	25	65	92
Total Income	10,197	9,629	8,822
Operating Expenses	9,996	9,436	8,915
Net Books Division	201	193	(93)
Journals Net	301	166	103
Net Pub. Operations	502	359	10

EDITORIAL AND MANAGEMENT BOARDS

Faculty serving on the MIT Press Editorial Board this year were Joshua Cohen, Carol Fleishauer, Rafael A. Bras, Jed Buchwald, Joseph Jacobson, Leslie Pack Kaebling, Nancy Kanwisher, Michael Scott Morton, and Board Chair William Mitchell. Frank Urbanowski and Ann Wolpert served as ex-officio members.

The MIT Press Management Board met twice during the year. Members of the Board were: Ann J. Wolpert, board chair and Director of MIT Libraries; Mary Curtis, President of Transaction Publishers; Joseph Esposito, former President and CEO of Tribal Voice, Inc.; Jack Goellner, Director Emeritus of Johns Hopkins University Press; William Arms, faculty of Cornell University; John Hanley, Chairman and CEO of *Scientific American*; Stephen Lerman, MIT Professor of Civil Engineering; William Mitchell, Dean of MIT School of Architecture and Planning; Richard Rowe, President of Rowe.Com; Jerome Rubin, former Group VP, *Times Mirror*; Richard Schmalensee, Dean, Sloan School of Management; Hal Abelson, MIT Professor of Engineering and Computational Science. Frank Urbanowski served as ex-officio.

SUBSIDIARY RIGHTS

Our subsidiary rights program has at its core the sale of translation rights to our books. The income generated by the licensing of foreign rights increased by slightly over 33% since fiscal year1999. The number of translation contracts increased from 83 contracts signed during fiscal year1999 to 108 during the same period in fiscal year 2000. The average size of the advances paid against royalties has remained stable, with the exception of mainland China, where we have begun to implement a policy of minimum advances and to ask for royalty scales more in line with those offered by publishers in the rest of Asia. Total income from translations was spread evenly over the list, including both front list and backlist titles. Our strongest disciplines in the translation market are economics and cognitive science.

A significant shift over the last few years has been the increase in income from our reprint program, which includes permission to photocopy and to publish excerpts from our books. During this past year, *The Sciences* of the New York Academy of Sciences featured first-serial rights excerpts of Ubel's *Pricing Life* and Thornhill and Palmer's *A Natural History of Rape.*

In the category of reprint sales, we have begun to license selected English language reprints in those markets where we forecast limited income from sales of our own edition. Income from our reprint program increased by four percent since fiscal year 1999, and constitutes a substantial portion of total subsidiary rights income.

During fiscal year 2000 income from sales to book clubs increased by 53% since fiscal year1999. Following a period of consolidation and reorganization in the book club industry, the number of MIT Press titles featured has increased gradually. Although most titles are purchased by book clubs as alternate selections, in recent months book clubs under the same umbrella have begun to make joint purchases. This market continues to be the least predictable for subsidiary rights and depends both on our publishing list and on the financial formula required by book clubs.

Income from the license of electronic rights during fiscal year 2000 declined by 21%. This figure is somewhat misleading: We make a distinction between sales of the entire book in electronic form and sales of portions of books for which we receive royalties on the basis of frequency of access. Only the second category is included as subsidiary rights income.

Overall, subsidiary rights income in fiscal year 2000 increased by 19.7% since fiscal year1999.

Table 2. Subsidiary rights income FY98-FY00

	FY98	FY99	FY00
Translations	$200,507	$149.078	$198,668
Reprints	$145,706	$193,356	$206,484
Book Clubs	$1,416	$2,683	$4,098
Electronic, AV rights	$8,003	$4,559	$3,574
TOTAL:	$355,632	$349,476	$412,034*

*Please note that this total reflects disbursement of royalties due an author who requested payment before the end of the royalty year.

MARKETING

In the past, The MIT Press Marketing Department had been conceived of as two separate, but coordinated, divisions: Marketing and Promotions. Functionally, however, we have operated as three: Domestic Sales, Promotions (Domestic), and International Marketing (i.e. International sales and promotions). With an increasing reliance on electronic promotional activities to sell our books, and with an increasing electronic component in the mix of Press content including software, CD-ROMs, and site licensing for individual book and resource web sites, it became clear that we needed to create another, distinct division within Marketing, one that would coordinate a cohesive electronic marketing program for projects within the Digital Projects Lab, Journals, and Books, and which would be responsible for keeping up with changes to the electronic market place, especially as it impacts our web site. We created the new position of Electronic Marketing Manager. Our former Bookstore Manager, Jeremy Grainger, accepted a promotion to this position in September.

Jeremy Grainger accepted this position, The MIT Press Bookstore was restructured and now reports directly to the Marketing Director, Vicki Jennings. The Bookstore's former Assistant Manager, Maureen Ziochouski, and Senior Clerk, John Jenkins, were promoted to Bookstore Co-Managers.

Reports from Domestic Sales, Promotions, Electronic Marketing and International Marketing Managers follow.

Domestic Sales

Domestic Sales in fiscal year 2000 remained strong, growing 7.8%. Backlist sales once again accounted for over 60% of total sales. The impact of websellers (particularly amazon.com, bn.com, and fatbrain.com) continues to widen the audience for our books and helps consumers find our backlist titles that are no longer on the shelves of independent and chain bookstores. The websellers' growing market share has significantly shifted our customer sales by type over the past year. Wholesaler and webseller sales account for 56% of domestic sales, while chain and independent sales account for 16%. We estimate that wholesalers still provide over 50% of MIT Press titles to websellers.

This sales reallocation and growth has allowed us to work out longstanding issues with Borders (which has been on hold since March 1, 2000). Sales to this major customer have been cut in half, but we are confident that when direct business resumes our efforts will yield a more profitable relationship for both sides.

Along with record sales, The MIT Press absorbed record returns. A proposed merger between Barnes & Noble and Ingram required Ingram to "bulk up" two of their largest distribution centers in anticipation of increased demand. When this fell through these titles were returned, accounting for their unusually large returns rate (23%) this year.

Although independent bookstores were down 2% there is great hope that the launch of Booksense.com this coming year will make them more competitive with websellers and rekindle consumer loyalty to their neighborhood bookstores. Since the majority of fulfillment for Booksense.com orders will come from wholesalers, it is still unclear whether or not we can expect to see a significant increase in the independent bookstore market share. The Booksense advertising campaign, however, has already proven itself to be a valuable branding tool that has helped independents maintain a prominent presence among the webseller and chain giants, ensuring a healthy and competitive bookselling industry for at least the near future.

Table 3. Sales for FY1998–FY2000

	FY98	FY99	FY00
College Bookstore	$1,941,348	$1,925,089	$2,060,030
Retail Bookstore	$2,356,109	$2,280,501	$2,016,205
Wholesaler/Jobber	$4,235,454	$5,360,783	$5,466,687
Web Booksellers	$344,607	$838,992	$1,539,029
Catalog Bookseller	$137,206	$79,293	$99,980
Individuals/Other	$1,272,086	$1,131,742	$1,335,769
TOTALS	$10,286,800	$11,616,400	$12,517,700

Promotions

Direct mail

We ended fiscal year 2000 with traceable direct mail sales of $220,476, down 18% from last year. Direct mail's bottom line continues to be hurt by online booksellers who can offer much quicker delivery than we can, as well as deep discounts on some titles. Nevertheless, we believe that direct mail remains a highly effective means of promoting MIT Press titles, whether customers choose to purchase these titles from us directly or from online booksellers; and statistics we receive from online retailers support this view. So online bookselling does not make direct mail any less important, but simply offers our customers yet another means to purchase our books; and Press-generated direct mail continues to be a crucial means of making customers aware of new and backlist books in their areas of interest.

Fiscal year 2000 direct mail sales were also hurt by a much weaker economics list than in past years. Economics—always our top direct mail money earner—was down $23,896 from last fiscal year. It once again leads the list with traceable sales of $41,234, but the decline is notable. We also decided to produce just one Computer Science catalog this fiscal year, which saved money in production and mailing but eliminated some direct mail sales we would otherwise have had.

In addition to two seasonal announcement catalogs, we produced 14 subject area catalogs, 2 special promotions, and numerous single book flyers over the course of fiscal year 2000. Economics continues to be our strongest direct mail list, followed by Cognitive Science with traceable sales of $30,631 and Neuroscience with sales of $29,295.

Textbook sales

Text sales in the U.S. and Canada were $2,937,950, an increase of 17% over last fiscal year. Unit sales were 143,604, an increase of 5% over last fiscal year. (These numbers are a bit skewed by the high number of college bookstores stocking Krieger/Mapping Boston and Cormen/Introduction to Algorithms; if these two titles are subtracted from total dollar sales, there is an increase of 11% over last fiscal year.)

Bestsellers in dollars were Kennedy/Macroeconomic Essentials for Media Interpretation 1E and 2E, Barro/Macroeconomics 5E, Viscusi/Economics of Regulation and Antitrust, 2E, Lynch/Site Planning 3E, and Dutta/Strategies and Games.

Bestsellers in units were Rasmussen/Experiencing Architecture, Kennedy/Macroeconomic Essentials for Media Interpretation, 1E and 2E, Summerson/Classical Language of Architecture, Krugman/Pop Internationalism, Conrad/ Programs and Manifestoes on 20th Century Architecture, and Krugman/Age of Diminished Expectations.

Twenty-eight text direct mail campaigns were prepared and mailed to 80,535 professors in the U.S.

Exhibits

The MIT Press exhibited books, journals and electronic products (including CogNet and ESPlanner) with our own staffed booths or tables at more than 60 U.S. professional and academic conferences in fiscal year 2000. We also

sent books for display via combined and free exhibits to an additional 100 U.S. meetings during this same time period. At-meeting sales (not including conference-generated orders mailed, faxed, or e-mailed in later) tallied $146,746 for fiscal year 2000. Our largest conference moneymaker was The Society For Neuroscience's annual meeting (October 1999, Miami Beach, FL), which generated $35,277.00 in at meeting sales. Sales dollars were also large for Allied Social Science Association Meeting (January 2000, Boston, MA-mainly economics and finance titles) which generated $11,554.00. Other large-revenue meetings included Supercomputing ($9495, Portland, OR, November 1999), Association for Research in Vision and Opthamology (Ft. Lauderdale, May 2000, $6904.00), The College Art Association ($6732.00, NYC, February 2000) and Toward a Science of Consciousness 2000 ($6090.00, Tucson, AZ, April 2000).

In addition to buying books on-site at meetings, U.S. conference attendees sent in $160,714 in orders after these meetings. This brings total sales generated by U.S. Exhibits in fiscal year 2000 to $307,460.

Advertising

Advertisements for MIT Press books appeared in almost 600 trade and scholarly journals and magazines, as well as conference programs and websites. All of these ads were produced in-house by our Advertising Manager. The continued focus of the advertising program is to implement better target marketing and wider exposure, with an eye to new print and online media, while staying under budget. Major ad campaigns were implemented for *e-topia, Billboard, Inverted Odysseys, Mapping Boston, Paying with Plastic, The Internet Edge, A Natural History of Rape, The Land That Could Be, Without a Map, History of Shit, Lingua ex Machina, Barbara Kruger,* and *About Face.*

Advertisements for these books appeared in such publications as *American Scientist, Technology Review, The New York Review of Books, The Economist, Foreign Affairs, The Nation, New Republic, Lingua Franca, Mother Jones, The New York Times Book Review, Art in America,* and *Artforum.* Banner ads were placed on the inomics.com website.

Publicity

The Press's books and authors continue to be covered by a wide variety of general and scholarly media, including national newspapers, magazines, and radio and television programs.

The most widely covered title of the year was *A Natural History of Rape* by Randy Thornhill and Craig Palmer, whose argument about the biological origins of rape generated a firestorm of controversy in the popular press and became a major news story in the United States and Europe. The authors discussed their views on U.S. television and radio shows including NBC's "Today" and "Dateline," CBS's "The Early Show With Bryant Gumbel," ABC's "World News Tonight," CNN's "CNN Live," NPR's "Talk of the Nation," and many others. Reviews, news stories, and opinion pieces about the book appeared in *USA Today, Time, Cosmopolitan, The New York Times, The New York Times Book Review, The International Herald Tribune, The Los Angeles Times, The Washington Post, The Boston Globe, The Chicago Tribune, The Dallas Morning News, The Detroit Free Press, The Hartford Courant, The San Jose Mercury News, the San Francisco Chronicle, the Associated Press, Scripps-Howard, Science, Nature, The New Scientist, The Guardian, The Observer, the Sunday Times of London,* and many others. Not all of this coverage was positive, but the authors' controversial views drew their share of supporters as well as critics, and the vigorous debate the book has stirred seems likely to continue for some time.

The two most favorably reviewed titles of the year were *e-topia: "Urban Life Jim—But Not as We Know It"* by William J. Mitchell and *Mapping Boston* by Alex Krieger and David Cobb with Amy Turner.

Mitchell's look at how technology is changing the places we live and work was reviewed by architectural, business, scientific, and general interest publications including *Architecture Magazine, Architectural Record, The Boston Book Review, The International Herald Tribune, The Independent (UK), The San Diego Union-Tribune, Business Week, Scientific American, The Washington Times, The Industry Standard, Interiors, The San Francisco Bay Guardian, Computer Magazine, Red Herring, CIO, Bookforum, and The Christian Science Monitor.*

Mapping Boston enjoyed enthusiastic coverage in New England and well beyond. *The Boston Globe* and *Boston Globe Magazine* covered the book extensively; reviews and articles also appeared in *The Boston Herald, The New York Times, The Atlantic Monthly, Metropolis,* and many others.

Exploring the Art and Science of Stopping Time, a CD-ROM on the life and work of Harold Edgerton, also drew enthusiastic coverage in major national media including CBS's "Sunday Morning" television program, *The New York Times's* science section, and a variety of arts and sciences magazines.

Electronic Promotion

We continued an extensive campaign of electronic promotion for our books in the fiscal year 2000. We posted announcements for all new professional and many new trade titles to outside e-mail listservs and Usenet groups in relevant fields, and we negotiated links from many outside websites to our own. In addition, we sent regular announcements to the "spam" lists — mailing lists organized by subject. These lists contain the e-mail addresses of visitors to our website who have either asked to receive announcements from us, or who have bought books or subscribed to journals. In subject areas in which we publish a great many books and/or for which we have a large number of email addresses, we sent announcements every month. We gave special attention to books that we felt would benefit the most and receive the most exposure from electronic promotion, which primarily included computer science, artificial intelligence, and robotics books. *Self-Stabilization* by Shlomi Dolev, for example, garnered 251 hits in a two-month period, while *Layered Learning in Multiagent Systems* by Peter Stone garnered 248. We also put extra effort into promoting books for which we felt a niche audience might exist on the Internet, such as *Digital Libraries* by William Arms, which received 451 hits in a two-month period after appearing on only a few select listservs. With help from the DPL, we monitored the number of "hits" the announcements for each book generated. Overall, we believe that such e-promotions have significantly increased traffic to our website.

Awards

Many MIT Press books and authors were recognized for excellence last fiscal year.

The MIT Press outdid itself in the 1999 AAP/PSP Awards sponsored by The Association of American Publishers/Professional and Scholarly Books Division. MIT Press books took first place in six categories and received an honorable mention in one category.

The winners were:

Excellence in Design and Production:
Mapping Boston edited by Alex Krieger and David Cobb, with Amy Turner; foreword by Norman B. Leventhal.

Psychology:
The MIT Encyclopedia of Cognitive Sciences, edited by Robert A. Wilson and Frank C. Keil

Honorable mention in Psychology:
Sex and Cognition by Doreen Kimura

History of Science and Technology:
The Languages of Edison's Electric Light by Charles Bazerman

Economics:
Globalization and History: The Revolution of a Nineteenth-Century Atlantic Economy by Kevin H. O'Rourke and Jeffrey G. Williamson

Computer Science:
Design By Numbers by John Maeda

Biological Sciences:
Sensory Exotica: A World Beyond Human Experience by Howard C. Hughes

The following MIT Press titles were selected to be included in the annual list of *Choice* Magazine's Outstanding Academic Titles, which was published in the January 2000 issue of the magazine:
Mind in a Physical World: An Essay on the Mind-Body Problem and Mental Causation, by Jaegwon Kim.
Confessions of a Medicine Man: An Essay in Popular Philosophy, by Alfred I Tauber.
Truth in Context: An Essay on Pluralism and Objectivity by Michael P. Lynch.

Lynn Margulis, co-editor of *Environmental Evolution: Effects of the Origin and Evolution of Life on Planet Earth,* was awarded the 1999 National Medal of Science.

The Human Relationship with Nature: Development and Culture by Peter H. Kahn, Jr., received the 2000 Book Award by the Moral Development and Education Group of the American Educational Research Association.

The Radiance of France: Nuclear Power and National Identity after World War II by Gabrielle Hecht won the 1999 Herbert Baxter Adams Prize for the best book in European History. The award is sponsored by the American Historical Association.

Ghost in the Shell: Photography and the Human Soul, 1850–2000 by Robert A. Sobieszek, was awarded the George Wittenborn Memorial Book Award for excellence in art publishing. This award was presented by the Art Libraries Society of North America (ARLIS/NA).

The Drive-In, The Supermarket, and the Transformation of Commercial Space in Los Angeles, 1914–1941 by Richard Longstreth, received the 2000 Historic Preservation Book Prize; the award is sponsored by Mary Washington College Center for Historic Preservation.

Design By Numbers by John Maeda, received an Honorable Mention for the 2000 American Association of Museums Publications Design Competition.

Mapping Boston by Alex Krieger and David Cobb, with Amy Turner, was awarded Second Prize for the 2000 American Association of Museums Publications Design Competition.

The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine by Shigehisa Kuriyama, was awarded the 2000 Oriental Medicine Journal Award for the Achievement of Excellence, as the most significant English-language text in the study of early medical history.

The Architecture of Red Vienna, 1919–1934 by Eve Blau, was the winner of the 2000 Spiro Kostof Award by the Society of Architectural Historians for its outstanding contribution to the understanding of urbanism and its relationship to architecture. The award was presented at the Society's annual meeting in Miami on June 16, 2000.

The MIT Press received the 2000 Diana Award for its outstanding lifetime contribution to the field of user documentation. The Award Chair particularly acknowledged MIT Press author Ed Barrett for the contribution of his books to this field.

MIT's President Emeritus Howard Wesley Johnson received the 1999 Gyorgy Kepes Fellowship Prize for his demonstrated excellence in both science and the creative arts. Howard W. Johnson has devoted more than 40 years to MIT and is the author of *Holding the Center: Memoirs of a Life in Higher Education.*

The Visual and Visionary: Art and Female Spirituality in Late Medieval Germany by Jeffrey F. Hamburger, a Zone Book, was awarded the Roland H. Bainton Book Prize in the category of Art and Music. The award is sponsored by the *Sixteenth Century Journal.*

The Visual and Visionary: Art and Female Spirituality in Late Medieval Germany also received the College Art Association's prestigious Charles Rufus Morey Award which is presented each year to a distinguished book in the history of Art.

Wonders and Order of Nature, 1150–1750 by Lorraine Daston and Katherine Park, a Zone Book, received the Pfizer Prize, the greatest honor bestowed by the History of Science Society.

Germaine Krull: Photography of Modernity by Kim Sichel was named Best Retrospective Winner in the Golden Light Award 1999 Photographic Book of the Year Competition; the award is sponsored by The Maine Photographic Workshops.

MIT Press authors Whitfield Diffie and Susan Landau were selected by The Institute of Electrical and Electronics Engineers (IEEE-USA) as joint recipients of the award for Distinguished Literary Contributions Furthering Public

Understanding of the Profession. The board recognized Diffie and Landau for their book *Privacy on the Line: The Politics of Wiretapping and Encryption.*

Makin' Numbers: Howard Aiken and the Computer edited by I. Bernard Cohen and Gregory W. Welch with the cooperation of Robert V. D. Campbell received the Science Books & Films Best Book Award in the category of Knowledge and Data Processing books for junior high and high school readers.

Six MIT Press titles were among the fifty honored by the Association of American University Presses (AAUP) for their *Superior Jacket Design.* The titles recognized are:
Sorting Things Out by Geoffrey C. Bowker and Susan Leigh Star. Designer: Ori Kometani.
The Bauhaus and America by Margret Kentgens-Craig. Designer: Jim McWethy.
The Information Resources Policy Handbook by Benjamin M. Compaine and William H. Read. Designer: Ori Kometani.
The Spatial Economy by Masahisa Fujita, Paul Krugman, and Anthony J. Venables.
Designer: Ori Kometani.
The Design of Animal Communication by Mark D. Hauser and Mark Konishi.
Designer: Ori Kometani.
Parts and Places by Roberto Casati and Achille C. Varzi. Designer: Ori Kometani.

The AAUP also recognized six MIT Press among the fifty titles they recognized for *Superior Book Design.* These titles are:
Mapping Boston edited by Alex Krieger, David Cobb, and Amy Turner. Designer: Yasuyo Iguchi.
What Is a Bridge? by Spiro N. Pollalis. Designer: Ori Kometani.
Women in Dada by Naomi Sawelson-Gorse. Designer: Ori Kometani.
Object To Be Destroyed by Pamela M. Lee. Designer: Ori Kometani.
Architecture and Modernity by Hilde Heynen. Designer: Jim McWethy.
The Bauhaus and America by Margret Kentgens-Craig. Designer: Jim McWethy.

The Bookbuilders of Boston recognized the following MIT Press jackets for their excellent design and composition:
The Architecture of Red Vienna by Eve Blau
Architecture and Modernity by Hilde Heynan
The Information Resources Policy Handbook by Benjamin M. Compaine and William H. Read
Noise, Water, Meat by Douglas Kahn
The Spatial Economy by Masahisa Fujita, Paul Krugman, and Anthony J. Venables
The Bauhaus and America by Margret Kentgens-Craig
Information Design edited by Robert Jacobson
Sorting Things Out by Geoffrey C. Bowker and Susan Leigh Star
The Favored Circle by Garry Stevens
The Springboard in the Pond by Thomas A.P. van Leeuwen
Space: From Zeno to Einstein by Nick Huggett
Mapping Boston edited by Alex Krieger and David Cobb

The Bookbuilders of Boston also honored the following MIT Press books for their creative designs, well-thought-out composition, and craftsmanship in printing and binding:

General Trade Illustrated:
Mapping Boston edited by Alex Krieger and David Cobb
Women in Dada edited by Naomi Sawelson-Gorse

Professional Unillustrated:
H.H. Richardson by Maureen Meister

Professional Illustrated:
The Historiography of Modern Architecture by Panayotis Tournikiotis
Le Corbusier, the Noble Savage by Adolf Max Vogt

Finally, the Bookbuilders of Boston presented a plaque to recognize *Mapping Boston* edited by Alex Krieger, David Cobb, and Amy Turner as Best Book of Show in the 43rd Annual New England Book Show.

International Marketing

MIT Press export sales during fiscal year 2000 rose 4.2% to $5.328 million. Total export sales of $5.328 million accounted for 29.9% of overall book sales for the Press.

On January 1st 2000 MITP established world pricing on all new and backlist titles. This eliminated all mark-ups (to higher export list prices), and now there's just one price available to all countries/markets/customers throughout the world. MITP's decision to go to world pricing was well received by international booksellers and became a very necessary step for MITP to remain competitive with similar university presses and academic publishers, and to cope with the aggressive marketing methods of the Internet booksellers and U.S. wholesalers. Additionally we now have a fair pricing policy for our end user customers.

During fiscal year 2000 our sales in the UK increased by one percent to $1.513 million though our sales in Europe increased by nearly 10% to $1.502 million, thus our UK office did nearly 50% of its sales in the UK market and 50% in European markets. It was a difficult year in the UK with chain booksellers, most notably with Waterstone's due to their substantial debts, diminishing budgets, de-stocking, low staff morale and high staff turnover, and endless schemes to try to turn the company around. A bright spot is the strengthening markets with UK wholesalers who supply the e-retail side of the trade. Also the new Tate Modern Museum opened in London during first half of 2000, and its bookshop immediately established itself as a key account for MITP. In Europe Germany is our lead export market with sales of $269,000 followed Holland with sales of $174,000, Sweden $154,000, France $115,000 and Italy $98,000.

MITP sales to the territories serviced by our Japan office (Japan office territories: Japan, South Korea, Taiwan, Hong Kong) are up 4.9% from Prior Year even though sales to Japan fell by 2% from Prior Year. Japan remains our second largest export market after the UK, yet we're anticipating flat sales for fiscal year 2001 due to cuts in both private and public university library budgets. Sales growth is expected to continue in other parts of the Far East and S.E. Asia mostly due improving regional economic conditions, to easing up on prepayment policy to select trade, to reestablishing realistic and workable credit lines to the trade, to competitive pricing on textbook orders, and to more proactive sales and marketing efforts.

Sales to Canada, our third largest export market, were up 11.7% to $597,000 despite the Chapters chain having cut back on ordering MITP new titles, and the Chapters account going on credit hold 6 weeks before year-end.

Our fiscal year 2000 sales to Australia were hurt mainly because of the weakened Oz dollar and by Baker & Taylor, Ingram and other U.S. wholesalers successfully servicing the Australian and New Zealand markets.

Table 4. International Book Sales By Area

	FY2000 Actual	**FY1999 Actual**	**Percent**
Australia	**$173**	**$191**	**-9. 6**
Canada	**$597**	**$534**	**11.7**
Japan	**$626**	**$639**	**-2.1**
UK & Continent	$3.190	$3.023	5.5
Other Export	$741	$723	2.4
Total Export	$5.328	$5.112	4.2%

ELECTRONIC MARKETING

The Electronic Marketing Manager develops and coordinates new features on the Press' home page. New features run approximately every few weeks for six to eight new homepages each year. Special enhanced web features are also coordinated by the EMM. The bulk of the EMM's work this year has been on the cross-divisional team developing and supporting MIT CogNet. A Charter Member drive for individuals was launched at the Cognitive Science Society meeting in August 1999; a trial version of the library site license model was launched at the American Library Association's annual meeting in June month. Response to MIT CogNet among the interdisciplinary scholars, researchers, librarians, and students served by the online community has been tremendous. (see the DPL section for more details).

The Press experimented with its first real-time e-commerce transaction model for downloadable software, *ESPlanner*, professional strength financial planning software for Windows developed using Institute Professor Franco Modigliani's life cycle modelling approach. (http://mitpress.mit.edu/esplanner/) In addition, the EMM is

involved in marketing two new software products WinEcon Microeconomics and WinEcon Macroeconomics. These CDs serve as supplementary learning modules for students in undergraduate level Economics classes. (http:/mitpress.mit.edu/winecon/)

Digital Projects Lab

A working draft of a 5-year plan for the development of a new product line devoted to the design and implementation of scholarly community web sites was put forward to the administration this past spring. The goal is for the DPL to become a self-sustaining cost-and-revenue center by fiscal year 2002. We anticipate undertaking 2 types of projects: sites funded, owned, and maintained by the Press and sites commissioned by outside clients, be they departments within the Institute (e.g. M.ArchNet), individuals, agents or nominally affiliated with MIT (e.g. the Aga Khan Trust, sponsor of ArchNet). The DPL is currently staffed by a general manager, a senior editor/producer, and two web development programmers.

Our first Press-owned initiative, CogNet (http://cognet.mit.edu/), will launch as a commercial-grade, fee-based service in September. To date we have 9600 registered, individual, non-paying members and 21 institutional site licenses. Our first client-sponsored project, ArchNet, will deploy as a prototype after closing out its initial development year in September. Design of our 2nd client site for the School of Architecture, M.ArchNet, should also begin in September. As of July 1st the DPL offices have relocated to 3 Cambridge Center.

On-line sales web sales history:
Fiscal Year 2000 $311,213.25; Fiscal Year 1999 $198,278.08; Fiscal Year 1998 $156,071.84; Fiscal Year 1997 $114,867.13

Table 5. MIT Press Bookstore sales through 4th Quarter FY00

MONTH	Total	%FY99	MIT	HC	MIT PB	Jrnls	Hurt	Misc	Non-MIT
July	56,162	+2.4%	15,180	8,772	552	3,593	2,855	25,210	858
August	64,168	-11.9%	16,811	11,807	647	3,353	4,079	27,472	925
September	66,298	-0.8%	22,034	11,617	933	2,895	1,983	26,837	958
October	82,125	+10.3%	22,590	11,818	503	4,149	2,922	40,142	1,481
November	62,655	+4.4%	16,626	9,758	446	3,911	2,412	29,502	992
December	65,903	+1.1%	18,454	8,120	237	2,778	3,973	32,341	1,274
January	49,335	+0.2%	20,335	7,583	265	1,734	3,000	16,418	611
February	63,355	-4.2%	22,441	10,728	503	3,106	899	25,678	932
March	62,337	+13.2%	16,595	8,921	317	2,694	1,473	29,337	969
April	60,171	-6.7%	14,843	10,124	404	2,340	1,078	31,381	1,124
May	61,103	-1.7%	15,835	8,372	326	4,574	1,663	30,333	986
June	58,476	-9%	15,844	7,517	729	3,061	1,830	29,495	1,046
FYTD00	**752,008**	**-4%**	**217,588**	**115,137**	**5,862**	**38,188**	**28,167**	**344,146**	**12,156**
compFY99	-1%	-12%	+9%	-53%	+19%	+7%			
% of sales $	29%	15%	1%	5%	4%	46%			
MITP portion	50% (down 6%)								

SALES

Sales were slightly down this quarter, but please keep in mind that we did not have a "dock" sale this last April as we did in 1999. If we did not include the ~30,000 in hurt book sales from this event in last years total, our performance this year would be about even. We do have another sale scheduled for September. Please also note the continued shift in Press vs. non-Press sales. The MIT Press share has dropped 6% with a corresponding increase in non-Press sales. This mirrors a general fluctuation in the number of books stocked in the bookstore for each category. We intend to reverse this trend slightly. On the local front, we continue to face stiff competition from online and local booksellers who offer deep discounts on their books.

OFF SITE SALES

We continue to actively pursue off-site sales around the MIT campus as a means to expand sales without expanding our physical store. Off-site sales were up 47% from $17,447 to $25,580 this year. The authors@mit series continues to be a success, contributing to roughly half of this total. MIT's Tim Berners-Lee and the Mapping Boston launch were our highest grossing authors@mit events while MIT's Philip Greenspun topped out the non-sponsored events with his frequent campus lectures.

STAFF

After an understaffed year we are almost back to a full head count with the addition of Margy Avery and Yves Etheart. Both are veteran booksellers coming to us from the Harvard Bookstore and are fitting in nicely at our bookstore. We are also bidding a fond farewell to Michelle Phelan who has been with the bookstore for several years.

FUTURE PLANS

We continue to develop our participation in MIT's "Internal Service Provider" program which will allow MIT departments to purchase MIT Press books from us directly through SAP. We also intend to have a redeveloped e-commerce site in place by the end of the summer. This will give our online customers access to thousands more books as well as all MIT Press titles. Other plans being considered in response to customer demand include a frequent buyer program, an Institute-wide discount policy, and free same day campus delivery.

JOURNALS

In fiscal year 2000, the Journals program had gross sales of $4.6 million, a 2 % decrease from last year because of our fulfillment system conversion. The deferred subscription reserve account stayed flat, ending the year at $1,946,544. The new journals added in fiscal year 2000 were *Reflections: The SoL Journal* and *Harvard Design Magazine*. *European Legacy* was transferred to another publisher.

The division ends the year publishing 38 journals. The others are: *Artificial Life*, *Assemblage*, *Chicago Journal of Theoretical Computer Science*, *Computational Linguistics*, *Computer Music Journal*, *Design Issues*, *TDR/The Drama Review*, *Evolutionary Computation*, *Harvard International Journal of Press/Politics*, *International Organization*, *International Security*, *Journal of Architectural Education*, *Journal of Cognitive Neuroscience*, *Journal of Cold War Studies*, *Journal of Economics and Management Strategy*, *Journal of Functional and Logic Programming*, *Journal of Industrial Ecology*, *Journal of Interdisciplinary History*, *Leonardo/Leonardo Electronic Almanac/Leonardo Music Journal*, *Linguistic Inquiry*, *NBER Frontiers in Health Policy Research*, *NBER Macroeconomics Annual*, *Markup Languages*, *NBER Tax Policy Annual*, *Neural Computation*, *Neurology and Clinical Neurophysiology*, *October*, *Perspectives on Science*, *Presence: Teleoperators and Virtual Environments*, *Real Estate Economics*, *Review of Economics and Statistics*, *Quarterly Journal of Economics*, *Studies in Nonlinear Dynamics and Econometrics*, and *The Washington Quarterly*.

More information about the MIT Press can be found on the World Wide Web at http://mitpress.mit.edu/.

Frank Urbanowski

DIRECTOR, LINCOLN LABORATORY

Lincoln Laboratory is a mission-oriented laboratory operated by MIT for the Department of Defense (DoD) carrying out research and development in surveillance, identification, and communications. During the past year, agencies of the DoD—namely, the Air Force, the Army, the Navy, the Defense Advanced Research Projects Agency (DARPA), the Ballistic Missile Defense Office (BMDO), and the National Reconnaissance Office (NRO)—supplied approximately 89% of the Laboratory's budgetary support. The Federal Aviation Administration (FAA) provided most of the non-DoD support, which additionally includes work for the National Aeronautics and Space Administration (NASA) and the National Oceanographic and Atmospheric Agency (NOAA). Lincoln Laboratory also carries out pre-competitive research with industry under approved Cooperative Research and Development Agreements. For the federal fiscal year 1999, Lincoln Laboratory received $350 million, supporting the efforts of 1200 professional technical staff.

The following administrative changes occurred at the Laboratory Steering Committee level. Mr. Lee O. Upton, Head of the Tactical Systems Technology Division, was promoted to Assistant Director on the retirement of Mr. Alan J. McLaughlin. Dr. Lewis A. Thurman was promoted to Head and Mr. Alan P. Bernard was promoted to Associate Head of the Tactical Systems Technology Division. Dr. Eric D. Evans was promoted to Head of the Ballistic Missile Technology Division. Dr. Roy S. Bondurant was promoted to Associate Head of the Communications and Information Technology Division, replacing Dr. Kristen Rauschenbach, who left the Laboratory to found a spin-off company. Mr. Frank D. Schimmoller, Chief Financial Officer, was promoted to Director of Administrative Operations.

Activity at the laboratory focuses on DoD tasks in surveillance, identification, and communications technologies, supported by advanced electronic technology and on air traffic control technology for the FAA. Technical work areas include radar and optical sensors, measurements, and systems; communications; signal design and processing; identification algorithms; lasers; solid state devices; digital technology, circuitry, and data systems; and tactical control systems. Unclassified summaries of several accomplishments during the past year are presented below.

SURVEILLANCE TECHNOLOGY

Fluorescence Detection of Biological Agents

The Bio-Aerosol Warning Sensor (BAWS), a UV-fluorescence-based detector of aerosols of biological origin, has been developed at Lincoln Laboratory to provide warning of a potential biological threat. The BAWS sensor is the result of a four-year development effort, and exploits the Laboratory's previously developed microchip laser as a high-power, compact source of short pulses for exciting the fluorescent signatures of biological particles. Within the last year one dozen BAWS test units were integrated with the prototype Joint Biological Point Detection System (JBPDS) and demonstrated successfully in field tests at Dugway Proving Ground, Utah. Lincoln Laboratory is now transitioning the technology to industry for quantity production of the BAWS.

Lincoln Near Earth Asteroid Research (LINEAR) Project

The LINEAR project operates a wide-area asteroid search program employing an advanced electro-optic search system originally developed for the Air Force space surveillance applications. Recent advances in large-format, highly sensitive charge-coupled-device focal planes with fast readout rates, combined with customized data processing systems, allow the LINEAR project to search an average of over 10,000 square degrees per month to a limiting visual magnitude of 19. During the period of March 1998 through June 2000, LINEAR searched 483,000 square degrees of sky and reported 2,172,640 observations, which were published by the Minor Planet Center at the Harvard-Smithsonian Astrophysical Observatory. The observations produced by LINEAR account for approximately 70% of the published observations generated worldwide during this period. This effort resulted in discovery designations for 419 new Near Earth Objects (NEOs)—a total of 1037 NEOs are now recorded by the Minor Planet Center—48 new comets, and over 68,000 main-belt asteroids. These discoveries account for over 70% of the worldwide discoveries of both NEOs and main-belt asteroids during this period. These results were obtained with a 1-meter telescope at the Lincoln Laboratory Experimental Test Site in Socorro, New Mexico.

New LANDSAT Sensor Design and Flight Program

Lincoln Laboratory is responsible for the design, development, and flight validation of the Advanced Land Imager (ALI) that will be launched on the National Aeronautics and Space Administration's (NASA) Earth Observing-1 mission. ALI is a land-imaging instrument that will demonstrate advanced technology to meet NASA's Mission to

Planet Earth science needs in the 21st century. The new technologies dramatically reduce the size, weight, and power of ALI versus the LANDSAT-7 Enhanced Thematic Mapper. Fabrication, calibration, and environmental testing of ALI have been completed and the instrument has been mounted on the spacecraft. Integrated system tests are nearly complete and the launch on a Delta rocket is scheduled for November 2000.

Multi-Sensor Fusion And Exploitation

Advances in sensor technology are driving emerging surveillance systems to incorporate spectrally rich sensors that cover larger areas. With this increase in data, there is an associated challenge to automate the data reduction process. Lincoln Laboratory has focused on automation techniques that enable both scene visualization and target detection. Scene visualization is accomplished by registering the multi-modality data to a three-dimensional site model and fusing the layers by using a model of the human visual system. Image mining techniques are applied to the fused data to automatically detect terrain features like roads, buildings, and trafficable areas. This information can then be used as contextual information for advanced target recognition algorithms.

An integrated visualization system to support the intelligence community was developed this year and is being deployed. This system provides an initial operational capability for visualizing color-fused three-dimensional scenes of areas of interest. Automatic search algorithms for detecting terrain features within these scenes can be trained by using a simple graphical user interface. This fundamental system is also being used by United States Special Operations Command to help enable night operations.

Hyperspectral Technology Assessment

Lincoln Laboratory continues to support the Hyperspectral Technology Assessment Program that will lay out the frame work to characterize the potential value of hyperspectral imaging (HSI) systems to DoD operations, and will apply the framework to identify opportunities for near-term technology development and demonstration. The Laboratory approaches include defining assessment measures (e.g., performance, complexity and sensitivity measures), developing HSI taxonomies (e.g., applications, algorithms and sensors), performing empirical analysis, an, developing a performance model (an end-to-end statistical model consisting of sensor, processing and algorithm modules). Interactions with programs of the upcoming HSI space missions (NASA's EO-1 Hyperion, Air Force's Warfighter-1 and Navy's Naval Earth Map Observer) has been an emphasis of the program as well. As space borne measurements become available during the next year, these data will provide further insights to operational HSI system capabilities.

MISSILE DEFENSE

National Missile Defense (NMD) Program

The DoD has a program to develop and deploy a system to defend the United States against a limited ballistic missile attack. Lincoln Laboratory is supporting the NMD program at both the system and element levels. System work focuses on evaluating discrimination architectures against postulated and potential threats. Element support emphasizes characterization and assessment of early-warning radar, prototype ground-based radar, and exoatmospheric kill-vehicle seeker performance, primarily through design and analysis of flight tests.

Theater High-Altitude Area Defense (THAAD) Program

The THAAD system is currently undergoing demonstration/validation flight testing at White Sands Missile Range, New Mexico. The system is designed to provide large-area defense against theater ballistic missiles. Lincoln Laboratory provides detailed characterization of the radar's performance. In addition, the Laboratory conducts testing and analysis of the baseline decision algorithms, as well as continuous development and transfer of discrimination-algorithm upgrades for the THAAD radar. This year the Laboratory developed and deployed a data-analysis workstation to collect THAAD data and evaluate discrimination performance.

Navy Theater Ballistic Missile Defense Technology Program

Over the past several years Lincoln Laboratory and the Advanced Electronic Guidance and Instrumentation System (AEGIS) program office have been developing a theater ballistic missile defense (TBMD) capability. This capability is separated into two programs: a Navy lower tier Area system and a Navy upper tier Theater-Wide (NTW) system. Both programs differ greatly from the current AEGIS anti-aircraft warfare capability. The challenges associated with detection, discrimination, and handover of hostile targets within a TBMD complex have been an area of active Laboratory work. The Laboratory has developed algorithms for synthetic wideband radar measurements and algorithms to improve infrared (IR) focal-plane performance, which includes the use of a two-color focal plane. These algorithms are particularly challenging for the NTW system performing discrimination in the exoatmosphere.

AIR DEFENSE TECHNOLOGY

Airborne Seeker Test Bed

The capabilities of modern air defense missile systems have been severely challenged by the advent of low-observable vehicles and modern electronic countermeasures. The Airborne Seeker Test Bed (ASTB) is an instrumentation platform developed by Lincoln Laboratory to investigate these challenges and identify appropriate seeker architectures and signal processing algorithms for dealing with them. The ASTB is based in a Gulfstream II aircraft and provides high-fidelity radio frequency (RF) and IR reference instrumentation sensors that are used in parallel with special-purpose wing-pod payloads carrying production seekers or sensors under test. The combination of the system under test with the instrumentation sensors yields insight into the performance of sensor systems and advanced signal processing algorithms.

This year, ASTB activities include two major test campaigns and integration of new seekers. Two test campaigns have been conducted in Nevada to continue evaluating the effectiveness of electronic countermeasures against modern surface-to-air missile systems. One of the targets in these campaigns is the Airborne Countermeasures Test System, which is described below. One of the principal sensors in use was the RF seeker pod, first flown in 1997. A control architecture was implemented for the RF seeker pod so that its actions can be controlled by a ground-based radar, allowing flight testing of target intercepts in which the tracking radar and the seeker share data and act as an integrated system. Because the ASTB also carries IR focal-plane arrays and IR seekers, these and previous flight tests also provide data to evaluate the degrading effects of background clutter on the detection and tracking of target aircraft. Two new RF seekers with different designs have been received, and each is being integrated into a flight-test configuration, with completion expected at the end of 2000.

Airborne Countermeasures Test System (ACTS)

ACTS is a Falcon-20 business-class jet converted to operate either as a versatile target for testing of current and future air defense missile systems or as a global positioning system (GPS)jamming platform. The ACTS can provide a variety of electronic countermeasures (ECM) and can be configured to operate at L-band, X-band for Ka-band. Two X-band towed decoys and a terrain bounce antenna can provide repeater and noise outputs and other ECM techniques including range- and velocity-gate pull-off and false targets provided by a digital RF memory. Situational awareness is provided by real-time communications and GPS. The ACTS has been operating since 1997, and in the past year, campaigns were conducted for DARPA and the Air Force.

Embedded Digital Signal Processing

Most airborne radars deployed in operation today form only a few signal products from the antenna array focused on retrieving target amplitude, velocity, and elevation/azimuth. Backscatter from land clutter or interference from jammers, however, can quickly overwhelm such systems. The DARPA Mountaintop program had previously demonstrated that a versatile solution to this problem exists in the form of digital beamforming—element-level signals are directly digitized and combined to form customized target beams that are specially designed to adaptively suppress both clutter and jamming. This type of beamforming is referred to as Space-Time Adaptive Processing (STAP). Early this year an embedded STAP system for clutter and jammer suppression in an airborne early-warning radar demonstrated real-time performance of 185 billion computations per second. The embedding goal was achieved by combining custom standard-cell front-end very large scale integrated (VLSI) circuits filtering followed by a commercially produced massively parallel processor with nearly 1000 computing elements. Software for the processor features a layered parallel implementation, wherein the application code is isolated from the underlying machine architectural details.

Advanced Radar Technology

The Lincoln Laboratory effort in support of a planned DARPA Discoverer II surveillance program was focused upon developing ground moving-target processing techniques for use with space-based radars. A laboratory prototype of a front-end processing approach for the demonstration system has been completed. Two custom bit-systolic array VLSI chips were used for each pair of receive channels to subdivide the 180-MHz data stream into 48 subbands, for a total of 54 billion operations per second. The down-sampled data, clocked at 10 MHz, is easily compatible either with onboard implementation of electronic counter-countermeasures (ECCM) and STAP or direct communication to the ground for subsequent processing.

COMMUNICATIONS AND INFORMATION TECHNOLOGY

Smart Sensor Web

Lincoln Laboratory has been selected as the system integrator for the Smart Sensor Web demonstration, a DoD multi-service, multi-national program. The program will develop a conceptual system design for a tactical information network for the lower-echelon warfighters. Products will include imagery to the warfighters from a variety of ground and airborne sensors; a sophisticated three-dimensional simulation capability for pre-mission planning; high-spatial-resolution weather forecasts; soldier physiological status; and a sophisticated profiled information delivery system. An operational test bed has been established at the Military Operations in Urban Terrain center at Ft. Benning, Georgia. A series of experiments have been planned to look at the functional components of such a system. Experiments begin in August 2000 and continue through April 2003.

Next Generation Terrestrial Networks

Under the Next Generation Internet initiative, DARPA has sponsored a unique dark fiber communications research and application test bed called Bossnet. Bossnet extends four modern optical fibers from MIT and MIT Lincoln Laboratory to the Washington D.C. area near DARPA, enabling terabit-per-second communication. The test bed became operational in December of 1999 and is planned to continue operations for four years. New optical transmission methods are being explored to extend the bit-rate times distance product beyond the current state of the art, resulting in lower installation and operating costs. New applications including Gbps video and collaborative visualization are being developed, and advanced switching technologies will be added to the network for improved functions. Bossnet connects to the national DARPA-sponsored Supernet; this national connectivity among researchers will spark future technology developments and user applications to harness the tremendous power and capacity of fiber-optic communications.

Military Satellite Communications

The movement of military operations to precision strike and information dominance has resulted in large increases in communications data-rate and volume requirements, especially to small mobile or transportable satellite terminals. This year the Laboratory initiated a program to develop advanced modulation, coding, and multi-user access techniques that can increase efficiency of use of limited allocated bandwidth and transmitter power for future (>2010) satellite communications systems. Combinations of higher-order signal constellations and Turbo coding appear particularly promising.

Laboratory development of a test bed to demonstrate higher-data-rate waveforms for DOD's next-generation protected satellite communication (satcom) system (Advanced EHF; 2004 launch) is nearing completion, with tests scheduled for September 2000. In addition, field demonstrations are being arranged with the Air Force of previously developed protocols for highly efficient transfer of bursty packetized data traffic over satellites. The Laboratory has developed interfaces to permit its satcom facilities to accommodate a heterogeneous mix of input/output devices in order to support the Services as they field the new medium-data-rate Milstar satcom system. The Laboratory continues to provide highly capable Milstar payload simulators for use by the Army at their user training sites.

Army Communications

There is an increasing awareness of the importance of information at all military echelons to ensure operational success. To provide this information, an integrated global communication system to provide connectivity between the sustaining base and the fighting forces is required. Satellite communications can provide the range and terrain independence required of the communication system, but the terminals must seamlessly integrate with both the military and public terrestrial communication system for data and voice transmission.

To provide this capability, Lincoln Laboratory completed this year a second 12-lb. Milstar satcom terminal and demonstrated operation at several Army bases. The terminal is novel in that it incorporates a web-server interface that is network addressable, supports multiple users, and implements router functionality. An encrypted voice-communication software application was developed as an example of the modern communication features that the new terminal design will provide the future Army. The program now is focused on a new antenna pointing system with a vehicle-motion-canceling design, and on developing algorithms to mitigate momentary blockage of the transmission path (by trees or buildings) to demonstrate a complete on-the-move satellite communications capability in a physical package that is easy to install on military vehicles.

Ocean Systems

Since the early 1990s Lincoln Laboratory has helped the Navy assess potential passive sonar signal processing improvements to compensate for the decreasing acoustic signatures from submarines. Several innovations adapted from Synthetic Aperture Array Radar techniques were shown to have promise. During the past several years many of these earlier ideas have been selected for transition to the operating fleet for evaluation. Two processing concepts for passive-array sonar are being transitioned to towed array systems in fleet operation: a full-spectrum normalizer algorithm that significantly improves operator displays has been tested at sea and an interactive passive acoustic classifier has been selected for testing in 2000.

The proposed entry of the submarine into support of warfare in the littorals raises the demand for high-rate communications with other assets in theater. In 2000, a comprehensive seatrial for a multi-element buoyant cable array demonstrated the benefit of spatial diversity. Adaptive combining was used to implement two-way communications with FLEETSAT at operationally significant data rates (>24 kilobits per second).

Automatic Speaker Recognition

Lincoln Laboratory has a number of ongoing research programs focused on automatically extracting information from digitized conversational speech. Extractable information includes the language and transcription of the speech utterances and the identity of the speaker. Automatic speaker recognition is the process by which a speaker's identity can be extracted automatically from the speech signal. The Laboratory introduced the use of Gaussian Mixture Modeling and Universal Background Modeling as a means of solving the speaker recognition problem. The National Institute of Science and Technology (NIST) runs annual evaluations to measure state-of-the-art performance in automatic speaker recognition systems and to foster technology exchange in the area. Lincoln Laboratory has participated in each annual NIST evaluation, recently participating in the 2000 evaluation. Of the 11 international sites competing, Lincoln Laboratory systems produced the best performance in three of the four tasks in this year's evaluation. Ongoing research focusing on improving speaker recognition performance on voice that is transmitted by using Internet Protocols (voice-over IP).

Speech Translation And Translingual Information Processing

Building on prior work in automatic language translation of text, Lincoln has initiated research efforts aimed at two-way interactive English/Korean speech translation; and automatic detection, extraction, and summarization of information from multilingual text sources, for an English-speaking analyst. During the past year, prototypes were developed of both systems. In addition, a summarization algorithm was developed, which automatically produces a brief summary of English language texts. Speech translation and translingual information processing were successfully demonstrated in June 2000, during a military exercise in Hawaii.

Intrusion Detection For Tactical Networks

Lincoln Laboratory has previously developed a novel network-intrusion detection algorithm, called bottleneck verification (finds illegal user to root transitions), which has shown high performance in environments typical of large military bases. During the past year, this technology has been successfully adapted to operate in a wireless military tactical network environment. A modified version of bottleneck verification was developed for and integrated into host computers (called Appliques) on the Army Tactical Internet, and an additional intrusion detection algorithm, called persistent object monitoring, was also developed and combined with bottleneck verification on the hosts. In February 2000, this new integrated Lincoln Laboratory intrusion detection algorithm was tested during a Tactical Internet exercise at Fort Huachuca, New Mexico. Performance was excellent, with successful detection of 8 of 11 intrusion attacks and no false alarms.

AIR TRAFFIC CONTROL

Automation Tools

Lincoln Laboratory is working with the FAA and NASA to enhance air safety, reduce controller workload, and increase airport capacity by developing planning aids for air traffic controllers. A FAA-sponsored effort is underway to develop algorithms that dynamically adapt air traffic control sectors to changing conditions, such as the passage of line storms. This activity will take advantage of new weather-forecast products developed in the Integrated Terminal Weather System (ITWS) program to adjust sector boundaries to minimize delay and avoid high-workload traffic concentrations.

Additional work sponsored by NASA Ames is being carried out to integrate advanced weather products developed by Lincoln Laboratory into the Center Terminal Automation System (CTAS) developed by NASA. CTAS helps coordinate activities between arrival controllers located at en route centers and final-approach controllers located at radar control facilities. The focus of initial work is on integrating wind field products from the ITWS in order to improve aircraft trajectory estimates. Concept exploration work is also underway on the use of ITWS convective weather products in CTAS for determining weather-impacted routes. NASA Ames is also sponsoring the Laboratory to develop the operational concept for the Surface Management System, a new automation tool to aid air traffic controllers with sequencing and separation of aircraft on the airport surface.

Surveillance Radar Improvements

The FAA is sponsoring the Laboratory to perform flight test validation of Automatic Dependent Surveillance Broadcast in the United States and Europe. The technology, developed at the Laboratory, uses the Mode S secondary radar frequency and data formats to broadcast aircraft-derived position and state information. It enables air-to-air and air-to-ground exchange of more precise and timely information in support of more efficient air traffic management. The FAA is also sponsoring the Laboratory to assist with the development of time-difference multilateration, a technique for surveillance of the airport surface that will form the basis for improved management of surface traffic and the prevention of runway incursions.

Aviation Weather Detection and Prediction

The Laboratory-developed ITWS will provide comprehensive information on operationally significant weather at large airport terminals. Real-time warnings and forecasts of wind shear and other thunderstorm hazards enhance aviation safety. Traffic management functions are improved by using high-resolution information on winds along flight profiles and forecasts of precipitation impacts on flight routes. The Laboratory has provided extensive support in transitioning the ITWS algorithms to a production contractor and validating the implementation. Performance evaluations and site adaptation studies will be conducted as the initial production systems are deployed. The Laboratory continues to operate ITWS testbeds at Memphis, Tennessee, Orlando, Florida, Dallas-Ft. Worth, Texas and New York, New York.

A Weather Systems Processor (WSP) for the Airport Surveillance Radar (ASR-9) has been developed by the Laboratory and successfully transitioned to an industrial contractor for implementation at 35 airports nationally. This system employs innovative signal- and image-processing techniques to detect low-altitude wind shear and track thunderstorm movement by using existing terminal aircraft tracking radars. Ongoing work will support algorithm refinement and site adaptation as the WSP is deployed nationally in 2001 and 2002.

A Medium Intensity Airport Weather System (MIAWS) has been developed to provide real-time, high-resolution information on thunderstorm location and movement at small airports that will not receive a Terminal Doppler Weather Radar, ITWS or WSP. MIAWS utilizes data from the National Weather Service's Doppler Weather Radars (WSR-88D or NEXRAD), together with Lincoln Laboratory–developed data-quality editing and storm-tracking software to address safety concerns raised by last summer's fatal commercial aviation accident at Little Rock, Arkansas. A Laboratory-developed MIAWS prototype is being tested at Memphis, Tennessee and Jackson, Mississippi.

The Laboratory supports the FAA's Aviation Weather Research program to develop improved mid-term (one to six hour) forecasts of convective weather, and ceiling and visibility changes at major airport terminals. These challenging forecast problems require appropriate sensor data processing, numerical weather modeling, and a variety of advanced weather forecasting technologies. Operational demonstrations are underway at five major U.S. airports.

A program is underway under NASA sponsorship to develop an Adaptive Vortex Spacing System. This will utilize meteorological data and forecasts, along with explicit detection of aircraft wakes to adjust aircraft separations on approach and arrival so as to exploit currently unused capacity when the vortices dissipate rapidly or blow quickly away from flight paths. Extensive measurements of wake vortices and boundary-layer weather conditions have been carried out at several airports to validate and extend models for wake-vortex behavior. The development of an operationally usable pulsed Doppler lidar for wake vortex and tracking is underway.

ELECTRONIC DEVICES

Advanced Optical Lithography

Lincoln Laboratory pioneered the development of photolithography with 193-nm wavelength lasers and its transition to the industrial semiconductor sector. This year the semiconductor industry announced first production of integrated circuits based on this technology for patterning transistor circuits at gate dimensions of 130 nm; with refinements this wavelength will support 100-nm dimensions. The Laboratory's current development of 157-nm technology has now emerged as the strongest candidate for supporting mass production of microelectronic devices at 70-100 nm gate dimensions in the years 2004–2007. The key novel technological elements at this short wavelength are the development of appropriate photomasks and photoresists. Lincoln Laboratory has in the last year developed an optimized 157-nm photoresist with better lithographic performance than any other currently available photoresist. It has also demonstrated patterning at the smallest dimensions ever achieved with optical means: dense lines and spaces with 90-nm pitch using 157-nm interference lithography. The combination of these two achievements is a major step towards the development of a production-worthy 157-nm lithographic technology.

For the nearer term, functional transistors exploring the device limits of CMOS technology have been fabricated with 25-nm gate lengths by using phase-shift optical lithography in a industry-standard 248-nm exposure tool. This patterning at linewidths as small as 10% of the exposure wavelength, while it is a technique which is limited in its ability to print finely pitched structures without multiple exposures, is an effective means to create select isolated small gates, and thus can extend microelectronics by leveraging the large optical infrastructure existing at whatever wavelength is extant in the semiconductor industry.

Nasa Chandra X-Ray Great Observatory

The charge-coupled-device (CCD) detector arrays on the NASA Chandra X-ray observatory were developed at Lincoln Laboratory in collaboration with the MIT Center for Space Research. Since its launch in July 1999, Chandra has met expectations and supplied a wealth of new discoveries, including the detection of the most distant known object some 14 billion light years away. The CCDs have also provided richly detailed images with an angular resolution 100 times better than previous missions, enabling among other things the detection of a long-sought neutron star in the supernova remnant Cassiopeia-A. The CCD detector arrays have provided data for more than 60 scientific papers to date, and are expected to support research in the field over the planned 5-plus years of the Chandra mission.

David L. Briggs

DEAN, SCHOOL OF ARCHITECTURE AND PLANNING

The School of Architecture and Planning deals with a far wider range of fields and issues than its name might suggest. In addition to the Department of Architecture (the oldest such department in the country), and the Department of Urban Studies and Planning, it houses the Program in Media Arts and Sciences, the Media Laboratory, the Center for Real Estate, the Center for Advanced Visual Studies, and the Aga Khan Program for Islamic Architecture. There are many cross-connections among these units, and together they address issues of the human environment—in all its aspects—on a very broad front.

The School was extremely active during the 1999–00 academic year. There were particularly exciting developments in faculty hiring, in initiation of new research and teaching ventures, and in improvement of physical facilities.

FACULTY

The strength of the faculty continued to grow during 1999–00, and there were important faculty appointments in all units of the school.

In the Department of Architecture Ann Pendleton-Jullian and Andrew Scott were granted tenure. Julie Dorsey also received tenure and will now divide her teaching between the Department of Architecture and the Department of Electronical Engineering and Computer Science. John Fernandez joined the Building Technology group as an Assistant Professor. Internationally acclaimed architect and alumnus Charles Correa was appointed the new Bemis Professor. Two new Assistant Professor appointments were made in the History, Theory, and Criticism group: Erica Naginski, a specialist in French nineteenth century art, and Arindam Dutta, an expert on Indian architecture and colonial institutions.

In the Program in Media Arts and Sciences (MAS) Ted Selker, a former IBM Fellow, was appointed Associate Professor and director of the Media Lab's new Context-Aware Computing Group. Deb Roy, who recently received his Ph.D. from the Media Lab's Perceptual Computing Group, was named Assistant Professor and leader of the new Cognitive Machines Research Group. Justine Cassell, head of the Media Lab's Gesture and Narrative Language Group, was promoted to Associate Professor without tenure. Neil Gershenfeld, director of the Media Lab's Physics and Media Group, was promoted to Associate Professor with tenure. Joseph Jacobson, who heads the Media Lab's Nanomedia Group, was promoted to Associate Professor without tenure. John Maeda, head of the Media Lab's Aesthetics and Computation Group was promoted to Associate Professor without tenure. Mitchel Resnick, director of the Media Lab's Lifelong Kindergarten Group, was promoted to Associate Professor with tenure.

In the Department of Urban Studies and Planning (DUSP) Associate Professor Timothy Riddiough was granted tenure and Terry Szold was promoted to Adjunct Associate Professor. Keith Hampton was selected to join the Department as an Assistant Professor of Technology, Community and Urban Sociology. Distinguished Professor Anne Whiston Spirn accepted a joint appointment in DUSP and the Department of Architecture where she will teach landscape architecture and planning.

An overriding concern and goal for the School is to increase the diversity of our faculty and students. Over the past few years, with help from the Provost's special programs, we've had great success in attracting women and minorities to the School. We continue to apply aggressive recruitment efforts in every faculty search.

SPACE

Plans for the new seven-story Media Lab complex, designed by world-renowned architect Fumihiko Maki, are moving ahead. The complex will house three centers: the Okawa Center for children, learning and developing nations, a center focused on the underlying science and technology needed to merge digital with physical bits, and a center dedicated to arts and expression. The scheduled date of completion for the new complex is 2003.

Renovations were completed in Building N51, transforming a former classroom and corridor area into a cohesive, highly networked research cluster uniting House-n, the Emergent Design Group, and the Design Computation Group. The new space has double height, suitable for large-scale mockups of experimental interiors. It opens into a contiguous faculty office and student workstation suite modeled on similar spaces in the Media Lab. An expanded classroom in N51-348 was also created and much needed security upgrades were made in Buildings N51 and N52.

An office for the ArchNet project was established in a newly renovated space in Building 10-322. This space includes one private office and built-in workstations in an open outer office.

At the Center for Real Estate (CRE,) the Blakeley Lecture Hall was completely renovated and now includes a state-of-the-art computer projection system.

EDUCATIONAL INITIATIVES

Departments throughout the School continued to innovate in response to emerging conditions and opportunities.

In September 1999 an ambitious project called ArchNet was launched at the School of Architecture and Planning, in close cooperation with The MIT Press and with support from The Aga Khan Trust for Culture. ArchNet is an extensive online community resource dedicated to architecture, urban design, and urban development with a special focus on the Islamic world. It will be made accessible to scholars, practitioners and interested non-specialists through the Internet. More information can be found at http://archnet.org/.

In the Department of Architecture a student exchange program with the Technical University Delft was established. The undergraduate program benefited from attention to its core curriculum and enthusiastic faculty advisors. There were notable improvements in undergraduate architectural studio work. The Building Technology (BT) group collaborated with Harvard's Graduate School of Design to create a web site for advanced building envelope systems. Special programming and increasing collaboration between studio professors and Building Technology professors created an opportunity for significant teaching and research in several key areas including sustainability.

During the 1999–00 academic year, the Program in Media Arts and Sciences (MAS) admitted the first 14 students into its new, alternative freshman-year program. The students enrolled in Media Lab recitation sections of core freshman subjects', pursued Media Lab UROP research projects, and participated in two new MAS undergraduate subjects on research and design. This is intended as the first step towards establishing a full-fledged undergraduate program.

In May 2000, the Media Laboratory announced a 10-year collaboration with the Republic of Ireland to establish MediaLabEurope (MLE) in Dublin. Research at this independent, university-level educational center will at first focus on learning and education, arts and expression, and e-commerce. The Media Lab and MLE will share all intellectual property developed over the initial 10-year period.

During the 1999–2000 academic year, the Undergraduate Committee in the Department of Urban Studies and Planning (DUSP) redesigned its undergraduate major into three tracks: Urban and Environmental Planning, Urban Studies, and Urban and Regional Public Policy. Undergraduate DUSP students participated in the first year of the new interdisciplinary Minor in Public Policy program. The Master's in City Planning (MCP) Committee began developing a one-year, mid-career MS program. The Ph.D. Committee started reviewing requirements for the five alternative "First Fields" in the Ph.D. general examination. The Environmental Policy Group (EPG) modified its curriculum, adding a series of methods modules and new courses on brownfields redevelopment, environmental leadership, and industrial ecology. DUSP graduate students launched a new national refereed journal, *Projections*.

At the Center for Real Estate (CRE) the fifteenth summer of professional development courses brought 452 attendees to campus during the summer of 1999 to enroll in nine courses, including one new course, an "Introduction to Portfolio and Asset Management." The Center's 2000 Summer Institute offered two new courses on the subjects of green development and structuring complex transactions. In the professional degree program, course content continued to evolve as the real estate industry changed, especially in the areas of finance and real estate capital markets.

Eleven students joined the Center for Advanced Visual Studies (CAVS) as UROPs and graduate Research Assistants this year. Professors Glorianna Davenport and Stephen Benton conducted a weekly seminar series, "MAS 879: Experiences in Interactive Expression" which brought artists Natalie Jeremijenko, Christopher Janney, Don Ritter, George Fifield and Perry Hoberman to MIT for a day of meetings with students and faculty. The seminar culminated in an exhibition of student-produced interactive installations at CAVS. An emerging mission of CAVS is the exploration of digital arts in collaborative projects with the goal of creating significant art unique to MIT.

EVENTS AND AWARDS

The academic year showcased innovative work from within the School as well as offering us the chance to learn from leading international figures in design.

This year in the Department of Architecture the Pietro Belluschi lecture was given by Alvaro Siza. Christian Menn delivered the third Felix Candela lecture. The Arthur H. Schein Memorial Lecture was given by Daniel Libeskind. Professors Dennis Adams and Krzysztof Wodiczko were both selected for representation in the prestigious Whitney Biennial in New York. Professor Wodiczko was also invited to participate in the Venice Biennale, the Kwang-ju Biennale (Korea,) and had a retrospective exhibition at the Hiroshima Museum of Contemporary Art. Assistant Professor Wendy Jacob had exhibitions in St. Louis and Montreal, and was involved in a collaborative project with HaHa in Toulouse, France. An international conference, "Interpreting Aalto: Baker House and MIT" was held in October to celebrate the renovation of MIT's Baker House and honor its renowned Finnish architect, Alvar Aalto. In November 1999, the Visual Arts Program faculty organized an international symposium to honor Professor Krzysztof Wodiczko, recent winner of the distinguished Hiroshima Prize.

In the Program in Media Arts and Sciences Professor Stephen A. Benton received the 1999 Dennis Gabor Award from the SPIE: International Optical Engineering Society, in recognition of his contributions to the medium of holography, including his invention of white-light holography. Hiroshi Ishii received the MIT Perkins Award for Excellence in Graduate Student Advising. Joseph Jacobson was selected by *Technology Review* as one of the 100 young innovators who "exemplify the spirit of innovation in science, technology, business and the arts." Professor Jacobson and his students were awarded the 2000 Gutenberg Prize for printed display and electronic inventions. John Maeda received the prestigious Daimler Chrysler Design Award. Nicholas Negroponte was the 1999 recipient of the Boston Museum of Science's Bradford Washburn Award. Alex Pentland was elected a Senior Fellow of the Design Futures Council and Rosalind Picard was named a Senior Member of IEEE. Mitchel Resnik's Computer Clubhouse, an innovative after-school program for underserved youths, was awarded a $20-million grant by Intel to create a national, and eventually international, Intel Computer Clubhouse Network.

The Association of Collegiate Schools of Planning (ACSP) gave its Outstanding Planning Educator Award to Professor Emeritus Lisa Peattie. Professor Karen Polenske was awarded the ACSP Margarita McCoy Award for Outstanding Service to Women Faculty at ACSP Schools. Assistant Professor Eran Ben-Joseph won the MIT Wade Award. During the academic year, faculty and students in the City Design and Development Group (CDD) organized and participated in the "Northeast Mayor's Institute on City Design." Faculty members in the Environmental Policy Group (EPG) facilitated a campus-wide initiative exploring scientific and political controversies surrounding the worldwide introduction of genetically modified organisms. The Housing, Community and Economic Development (HCED) group conducted a weekly speaker series concentrating on workforce development and community organizing initiatives. The Special Program for Urban and Regional Studies (SPURS) organized a seminar, "Facing Challenges: People, Market and Cities." The Center for Reflective Community Practice (CRCP) implemented several local technology initiatives and also conducted over a dozen community-based events and seminars, including a forum on Culture, Community and Technology with folk singer and activist, Pete Seeger.

The Aga Khan Program for Islamic Architecture (AKPIA) organized a Fall 1999 lecture series, "Seeing Others, Seeing Ourselves." "Contemporary Architecture in the Islamic World," was the subject of the Spring 2000 lecture series. Visiting Professor Hasan-Uddin Khan conducted a seminar on "Communities of Resistance: Globalization, Tourism & War." Howayda al-Harithy, Visiting Associate Professor, led a seminar on "Issues in Islamic Urbanism: Politics of City Formation and Transformation in the Muslim World."

The Center For Real Estate (CRE) celebrated its 15th year anniversary with a September symposium, "Real Estate in a Global Economy," attended by more than 300 alumni, members, and friends. Featured presenters were economist and Visiting Professor Roger Brinner and Epoch Foundation Professor of Management Donald Lessard who spoke about "hot economies and hot money." The Center also hosted a lively, well-attended members meeting in May featuring a discussion about the impact of e-business on the real estate services industry. Robert Danzinger, retired Chairman of Northland Investment, organized and led the popular Real Deals speaker series for the fourth year in a row.

Center for Advanced Visual Studies (CAVS) Senior Fellow Elizabeth Goldring and Fellow Seth Riskin received an MIT Council for the Arts grant for their *Eye Dance* project. Riskin also was a co-recipient of a Dance Umbrella commission award for developing *Light Dance*, performed in the *Boston Moves 2001* dance concert in June.

An exceptional number of outstanding applications were submitted for the inaugural Harold Horowitz Student Research Fund Awards. Established through the generosity of alumnus Harold Horowitz (AR51,) the awards support student-initiated research projects and assistantships. This year's recipients were: Singh Intrachooto, Architecture, Ph.D. candidate; Kay Paelmo, Architecture, BSAD candidate; Anthony Mo Townsend, Urban Studies and Planning, Ph.D. candidate and Megan Yakeley, Architecture, Ph.D. candidate.

The Ralph Adams Cram Award for outstanding interdisciplinary work at the Master's level was presented to Michael Fischer for his thesis, "Real Estate Development Exactions in Boston: Implications for Linkage and Planning in the South Boston Seaport District."

The seventh biennial Lawrence B. Anderson Award was presented jointly to School of Architecture and Planning alumni Scott Schiamberg, for his proposal, "Take Me Out To The Ballpark: For A Glimpse Of Green In The Last Of The Golden Age Ballparks," and Kairos Shen, for his proposal," The Wegner Chair."

More information about the School of Architecture and Planning can be found on the World Wide Web at http://sap.mit.edu/.

William J. Mitchell

DEPARTMENT OF ARCHITECTURE

While the teaching and research of the Department of Architecture have a remarkably broad scope, the core program remains the professional architectural degree (Master of Architecture). The strength and well-being of this program is fundamental in maintaining and enhancing our position as one of the most respected professional schools of architecture. Within and beyond the professional degree program, the department is engaged in the several domains of the discipline of architecture. Through the concept of "discipline" we understand the full constituency of architecture to be much broader in scope than the profession alone. On a department level "discipline" refers not only to architectural design but also to the other distinctive domains of our program: visual arts, building technology, and history, theory, and criticism of art and architecture. We are committed to a leading role in each of these areas and in the exploration of new technologies and electronic communications in relation to our physical and social environments.

The discussion below is organized by discipline group, followed by individual topics that cross discipline areas.

ARCHITECTURAL DESIGN

The statement below was prepared for the accreditation of our professional architectural design degree, but also emphasizes the interconnecting roles of all discipline areas in the Department.

Goals in Architectural Education

It is a commonplace that new theories and new technologies are changing our conception of what architecture can do and how architects conceive their tasks and accomplish them. The unique position of the MIT Department of Architecture is that we survey the development of theory from a decades-old departmental commitment to viewing such developments through the long lens of the history of criticism. We also view technology within an Institute which for a half-century has profoundly shaped and investigated technology's role in society. So we are open to—indeed are enthusiastic about—new technologies and theories. But we also feel impelled to test the results of our designing against long-held social and environmental values. As we embrace new conceptions of architecture, we demand of ourselves that our designs have the qualities of space, light, air, tectonic soundness, and place that allow for appropriate, even poetic, inhabitation.

Beginning studios (undergraduate and graduate) build up modeling and drawing skills by focusing those skills on an expanding range of ideas that the students must synthesize in their design projects. The first semester of Level II extends the core studio sequence for graduates and qualified undergraduates with a focus on tectonics—the making and the resultant expression of construction and architecture. Starting in 1999–2000 we continued the core sequence into the spring term of level II with studios devoted to housing. During that same term, MArch students develop a "concentration," a particular field of inquiry, which they continue to pursue through closely-focused design "workshops" and course-work in this and other departments.

Having "graduated" from the core sequence, MArch students in Level III choose that combination of diverse studio offerings which best meets their individual needs and desires. The insights gained in these studios and the concentration culminate, in the final semester, with the MArch students' theses.

Themes to Pursue

A hallmark of studio education at MIT is that instructors propose to their students not merely a project but a process by which that design might be accomplished. Our faculty use a shared set of themes as vehicles for advancing their pedagogies. Here are those themes, not imposed by departmental fiat, but observed and endorsed by all of us in mutual consultation:

- Tectonic Expression. We find among ourselves a poetic and pragmatic interest in how materiality, the manner of construction, and the means of managing natural forces (gravity, climate, airflow, etc.) might be expressed.
- Light and Inhabitation. We feel that attention must be paid to the capacity of light to transform and model space in ways appropriate to a range of human activities and emotions.
- Building Community. We believe that respect must be accorded to the identity and social needs of inhabitants of places, both to establish private territories for them and to enhance their abilities to participate in the public realm.
- Cultural Heritage. We respect the value of cultural difference and we seek strategies that preserve the legacy of artifacts and customs from the past while addressing the pressures and opportunities of the present.
- Urbanism. We are acutely aware of architecture's ability to contribute spatially, symbolically, and functionally to the shared but divergent social and economic life of cities.
- Engaging the Landscape. We understand the impact of buildings as material and experiential extensions of the land. We thus pay particular attention to the impacts that designed environments have on natural systems and vice versa.

- Sustainability. We feel a concern for the conservation of natural resources, not just in terms of the efficiency of the buildings we design and the practices our buildings foster among their inhabitants, but in terms of larger practices like settlement and transportation.
- Virtual Environments. We are fascinated by the use of digital media to study and represent physical spaces and phenomena. We recognize the opportunity such media afford to design sites, software, and protocols that may foster a sense of inhabitation, of place, in cyberspace.

Studio Visitors

The noted Greek architect Dimitris Antonakakis once again taught with us in the fall term. The distinguished Japanese architect Fumihiko Maki and the noted Indian architect Raj Rewal were short-term visitors, as will be Maki again next year. A young, emerging local architect, Maryann Thompson, will also continue as a visitor after her successful appearance last year. During the year we secured a long-term visiting relationship with internationally acclaimed architect (and alumnus) Charles Correa, the new Bemis Professor.

Admissions

Admissions results for the professional MArch were less strong or at least more ambiguous than the notable success of last year. The pool of applicants for our 3-1/2-year program was viewed as very strong and deep. Ranking these applicants with little previous background in architecture is an uncertain activity, but we do our best. This year we secured fewer of our top ranking applicants. Taking the pool as a whole we had the same results as in other years – and we are encouraged by the perceived depth of the pool. These students come almost wholly from the most prestigious private colleges and universities. As usual our principal competitor was Harvard; Yale strengthened while Princeton and Columbia waned. Last year I recorded the results of admissions to the 2-1/2 year advanced standing program as literally unbelievable: nine of the ten top-ranked candidates; 10 of 13; 16 of 20. We were over-subscribed with 20 enrolling. This year we cut back on admissions, admitting our targeted 12, more evenly distributed over the rankings—still including three of the top seven and five of the top 14. Most of these students come from major public universities, here and abroad. Harvard weighed even more heavily than before as a competitor; indeed, it was virtually the competitor.

Promotions and Changes

We are pleased by notable success in the promotion of Architectural Design faculty. Both Ann Pendleton-Jullian and Andrew Scott, architecture studio faculty, were promoted to tenure. Julie Dorsey, active in computation and design, was promoted to tenure; however, she will now share her teaching between Architecture and Electrical Engineering and Computer Science with her dominant position in the latter. Ellen Dunham-Jones, both a studio professor and teaching a required history subject, will leave to direct the architecture program at Georgia Tech. She has been an accomplished teacher and a devoted colleague; we will miss her. We will conduct a search for a new junior studio professor. Michael Dennis was on leave in the spring term.

Research

Samples of research by faculty in Architectural Design include: sustainability (Andrew Scott); New American School Design Project, now with remarkable strength in his work in Paterson, New Jersey (Roy Strickland); emerging urbanism (Ellen Dunham-Jones); visualization (Julie Dorsey); shape grammars (George Stiny, Terry Knight); space planning and organization (William Porter and Fernando Domeyko); computation and unbuilt architecture (William Mitchell, Takehiko Nagakura); Emergent Design Group (Peter Testa); design in developing countries (Jan Wampler, Reinhard Goethert); urban design (Michael Dennis, Julian Beinart); and the American landscape (William Hubbard).

Architectural Practice

Established practices are conducted by Michael McKinnell and Michael Dennis. Smaller practices include those of Ann Pendleton-Jullian, Jan Wampler, Shun Kanda, and Paul Lukez. Among built works, a production facility on Okinawa by Nagakura and a chapel in Chile by Domeyko received much favorable attention.

Professional Association

Our special association with the offices of Renzo Piano in Genoa and Paris is off to a strong start with the first two annual student internships. Similar relationships have started with the Takenaka office in Tokyo and the engineering office of Ove Arup & Partners in London. Another such relationship is being explored with the architectural office of Norman Foster, also in London. These are all among the most distinguished practices in the world.

Institutional Association

For some years we have had an exchange program with the department of architecture at Cambridge University. With the advent of the general MIT/Cambridge exchange, we will look for enhancement of this relationship. This year we completed the arrangement to exchange students with the Technical University Delft, including our undergraduates. Dunham-Jones and Lukez were central to the Delft initiative.

BUILDING TECHNOLOGY

The Building Technology (BT) group continues a strong research record and specialized graduate instruction. Critical reflection is being directed toward enhanced teaching both at the undergraduate and professional architecture levels.

Research

Leon Glicksman, Qingyan Chen, and Les Norford, joined by the architect Andrew Scott, are engaged in major research and design work in China involving energy issues and environmental sustainability at several levels: materials, dwelling units, and the site organization of large housing developments. Residential demonstration projects are in Beijing, Shanghai, and Shenzen. Glicksman and Chen conduct research through our laboratory for the study of indoor air quality, thermal comfort, building energy analysis, heating ventilating, and air-conditioning (HVAC) system control and design. This includes new research on natural ventilation in US applications. Norford and Julie Dorsey are working on a computational tool to aid architects in complex lighting designs. A new initiative is that of Norford and Glicksman to develop sustainable guidelines for MIT's new and refurbished buildings. There is also collaboration with Harvard's GSD on a web site for advanced building envelope systems.

Faculty Matters

Glicksman and Chen were both appointed to named chairs. With the appointment of John Fernandez as an assistant professor there will now be renewed attention to research in building materials and assemblies. He has received funding from 3M for the study of natural fiber reinforcement. Chen and Glicksman received ASHRAE awards for best paper and for best poster presentation. Barry Webb, noted Australian lighting designer whose work will be prominent in the Sydney 2000 Olympics, and Carl Rosenberg of Acentech teamed again to teach lighting and acoustics.

Professional Association

What most observers consider the most distinguished engineering firm world-wide, Ove Arup and Partners, headquartered in London, continues a close relationship with our department, both in architecture and building technology—only enhanced by the status of our former colleague, Chris Luebkeman, as a director of Arup.

HISTORY, THEORY, AND CRITICISM

The faculty and graduate students of the History, Theory, and Criticism (HTC) group continue a strong record of research and publication. Graduates of the advanced degree programs also continue to receive excellent teaching positions throughout the world. With Michael Leja's presence, the undergraduate teaching has been especially strong.

Research and Publication

All members of the group regularly contribute to major journals in their fields and/or to catalogs or edited works. New books this year were: Henry A. Millon, ed., *The Triumph of the Baroque* (New York: Rizzoli, 1999); Mark Jarzombek, *The Psychologizing of Modernity* (Cambridge/New York: Cambridge University Press, 2000) and Stanford Anderson, *Peter Behrens: A New Architecture for the Twentieth Century* (Cambridge, MA: The MIT Press, 2000).

Faculty research interests include architecture and urbanism of modern Europe and America, architecture and epistemology, historiography, architectural theory, urbanism in pre-modern Europe, late medieval and Renaissance architecture, classical and medieval Islamic architecture and urbanism.

Faculty Matters

This group continues to undergo rapid change. The loss of an art historian and an architectural historian in the previous year, resulted in two new assistant professor appointments: Erika Naginski (PhD, Berkeley), a specialist in French nineteenth century art, a member of the Society of Fellows at Harvard, and with recent appointments at the University of Michigan; and Arindam Dutta, who is completing a dissertation on architecture and colonial institutions in his native India for the Department of Architecture at Princeton. A search will be conducted for a junior professor in the Aga Khan-funded line vacated when Nasser Rabbat became our Aga Khan Professor. Rabbat was on leave in the fall and spring terms. It was noted above that Ellen Dunham-Jones of the architectural design faculty is leaving to direct the architecture program at Georgia Tech; she also departs from her valued role as teacher of a subject on contemporary architecture and discourse required of MArch students. To our great regret, Michael Leja accepted a position in the distinguished program for American art and architecture at the University of Delaware. Leja's teaching received the highest commendation from undergraduate and graduate students, and he is an outstanding colleague. He will be extremely difficult to replace.

General

Doctoral students entering their non-resident research stage continue to win prestigious external research grants. Devoted faculty and staff deserve credit here as well as the winning students. But here too we must note an important

loss. Diane Tavitian, departing as principal staff member for HTC, deserves much credit for the successful operations of HTC, not least the success of the graduate students in winning grants.

Student Financial Aid

As for all units of the department, student financial aid has been and remains a crucial issue. In HTC this appears dominantly as financial packages that will attract the best candidates for the PhD program. What appeared forcefully this year, is that the traditional competitors of the HTC program (Princeton, Harvard, Columbia, and Cornell especially) have greatly escalated their offers to incoming students. We are now radically disadvantaged in this competition.

VISUAL ARTS

The Visual Arts Program (VAP) supports the undergraduate education curriculum of the Institute and also conducts a small graduate program. Its faculty includes a remarkable group of outstanding artists. In a small but selective mode, we are in a position to compete as one of the distinguished schools for contemporary artistic production.

Faculty Matters

Dennis Adams continues as the effective director of the Visual Arts Program (VAP). He is in a very productive stage of his own work having just completed a major work in Munich and beginning one for the Manhattan terminal of the Staten Island Ferry. Both Adams and Krzysztof Wodiczko were selected for representation in the prestigious Whitney Biennial in New York. Krzysztof also published the book *Critical Vehicles*. The distinguished performance artist Joan Jonas joined us as a full professor in January 2000. Edward Levine won a competition for a project in Fairmont Park in Philadelphia. Wendy Jacob, new as an assistant professor, impressed in her first year. She had a solo exhibition in St. Louis, was exhibited in Montreal, and was involved in a collaborative project with HaHa in Toulouse, France. Julia Scher had a solo exhibition at the Andrea Rosen Gallery in New York and participated in group exhibitions at the Castello di Rivoli in Italy and at the Musée d'art moderne in Bordeaux. The success of their work will take Wodiczko away all of next year, Levine in the spring term, and Adams in 2001–02.

Programs

The VAP faculty organized an international symposium on 20 November 1999 to celebrate Wodiczko on his winning of the distinguished Hiroshima Prize. Participants included Dominick LaCapra, John Rajchman, Eva Lajer-Burcharth, and Michael Leja. VAP collaborates with the Graduate School of Design of Harvard in organizing lectures and seminars with internationally-known artists who often appear first in our departmental lecture series.

UNDERGRADUATE PROGRAM

The undergraduate program has benefited from attention to its curriculum and a core group of committed and enthusiastic faculty advisors. There has also been a notable improvement in architectural studio work by undergraduates, including a significant amount of outstanding work. Nonetheless, a serious inquiry into the undergraduate program by a graduating senior points to a number of issues that need to be addressed. These include the negative impact of isolation of undergraduates in building N52 and a number of other factors that inhibit undergraduates from feeling appreciated and empowered for their own self-development and their potential contribution to the school. We plan to examine these matters and hopefully find ways to address them.

STUDENT FINANCIAL AID

Winning the best students: For all programs in the department, competition for exceptionally talented and motivated students remains high. Developing the means to offer competitive packages to students choosing architecture and its related disciplines, fields with long degree programs and low professional salaries, is a high priority.

Containing student debt as an institutional ethic: For the core MArch program, with its long duration, we view the problem of total debt of our graduates as an even more serious issue than initial attraction of students, not because we do not wish to compete for the best students, but because, in this degree program, there is considerable evidence that initial choices are based much more on the perception of the program than on the financial package. For those students who choose us, we should seek not only to give them a first-rate education, but also not to send them away with almost impossible financial burdens.

SPACE: RENOVATION AND DEPARTMENT CONSOLIDATION

Major renovations to our core facility continue and we trust that the goal of consolidating the department's teaching and support services will continue to be met phase by phase. Renovations in N51 transformed a former classroom and corridor area into a highly networked research cluster uniting House-n, the Emergent Design Group, and the Design Computation Group. Some studios and faculty offices, the Visual Arts Program, the wood and metal workshop, and the Indoor Air Quality Laboratory remain in N51/52.

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

The activities of the Aga Khan Program for Islamic Architecture of Harvard and MIT are reported separately in this volume.

PROGRAM ENROLLMENTS

A total of 225 students were counted in Course IV: 52 undergraduate, 92 MArch, 45 SMArchS/SM without specification, 10 SMBT, 5 SMVisS, 32 resident PhD, 25 Non-Resident PhD, 2 Special (non-degree) Students, and 2 non-Institute exchange students.

HIGHLIGHTS OF THE PAST YEAR

Student Awards

Student Awards designated by the Department or Institute: The William Everett Chamberlain Prize for graduating BSAD for achievement in design (Minna Ha). The Sydney B. Karofsky '37 Prize for the outstanding Master of Architecture student with one further year of study (Junko Nakagawa). The Francis Ward Chandler Prize for achievement in architectural design (Jae Kim). The Alpha Rho Chi Medal for leadership, service for the school and department, and promise of real professional merit (Michelle Apigian). The AIA Certificate of Merit for second-ranked master of architecture student (Ryan Chin). The AIA Medal for the top-ranked master of architecture student (Juintow Lin). The SMArchS Prize (Michelle Hoeffler, Garyfallia Katsavounidou, Axel Kilian, Mimi Levy). The Imre Halasz Thesis Award (Jae Kim). The AIA Foundation Scholarships (Amina Razvi, Dan Steger). Faculty Design Award (Lucy Fang, Ian Ferguson). Outstanding Undergraduate Prize (Kay Paelmo). Schlossman Research Fellow (Luke Yeung, Jorge Otero-Pailos). Ann Macy Beha Travel Award (Talia Braude, Henry Chang, Bianca Nardella, David Sledge). Louis C. Rosenberg Travel Award (Omar Khan, Amina Razvi). Marvin E. Goody Prize (Daniel Arons, Laurie Griffith, Tawing Louie). Aga Khan Program Summer Travel Grant (Sunitha Raju, Marianne De Klerk, Panayiota Pyla). Robert Bradford Newman Medal for Merit in Architectural Acoustics (Elizabeth Cordero, Michelle Hoeffler). Skidmore, Owings and Merrill Foundation Traveling Fellowship Nominees (Juintow Lin, Li Lian Tan). Renzo Pian Workshop Internship (Junko Nakagawa). Kristen Ellen Finnegan Memorial Award (Ann Volmann Bible).

External Awards: Fulbright Fellowship (Thomas Beischer). Mary Davis Fellowship, Center for Advanced Study in the Visual Arts (Alona Nitzan-Shiftan). Woodrow Wilson Postdoctoral Teaching Fellow (Ritu Bhatt). Arthur Goldreich Trust Research Award (Alona Nitzan-Shiftan). John Coolidge Fellowship (Adnan Morshed). John Coolidge Student Fellowship (Fernando Alvarez). Edilia and François-August de Montequin Fellowship (Fernando Alvarez). Association for Middle East Womens Studies Prize (Kishwar Rivzi).

Visitors and Lecturers

Visitors included: Edith Ackermann, Dimitris Antonakakis, John Fernandez, and Hasan Uddin-Khan in Architectural Design; Howyda Al-harithy, Barry Bergdoll, Martin Bressani, Hélène Lipstadt, John Rajchman, and Elisabeth Sussman in History, Theory, and Criticism; Edward Allen and Austin Parsons in Building Technology. Lecturers were appointed for the particular skills they could offer to the curriculum: Dan Greenwood, Paul Paturzo, and Maryann Thompson in Architectural Design; Robert Dermody, Carl Rosenberg, and Barry Webb in Building Technology; Leila Kinney in History, Theory, and Criticism; Barbara Broughel and Julia Scher in Visual Arts. Harvey Gantt was a Martin Luther King, Jr. Visiting Professor, a joint appointment with the Department of Urban Studies and Planning.

Lectures

The Department of Architecture Lecture Series brings outstanding scholars, practitioners, and artists to the School. In the fall, speakers were Silvia Kolbowski, Alice Friedman, Alex Tzonis with Liane Lefaivre, Henk Döll, Dimitris Antonakakis, Harvey Gantt, and Patricia Patkau. In the spring, speakers were Barry Bergdoll, Joan Jonas, Andy Foster with a group from Ove Arup & Partners London, Raj Rewal, Hermann Pitz, Barry Webb, and Galen Cranz.

The Pietro Belluschi Lecture was given by Alvaro Siza as part of the conference, "Interpreting Aalto." The third Felix Candela lecture (co-sponsored by Princeton University, The Structural Engineers Association of New York, and the MIT Department of Civil and Environmental Engineering) was given by Christian Menn. The Arthur H. Schein Memorial Lecture was given by Daniel Libeskind.

Symposium

An international conference with many distinguished participants (including Alvaro Siza and Juha Leiviskä) titled "Interpreting Aalto: Baker House and MIT" was held in October in celebration of the renovation of Baker House and recognition of its famed Finnish architect, Alvar Aalto.

Publications

The department publication *Thresholds*, now available by subscription, is well established as a means to communicate to alumni and friends of the School something of the intellectual life here. The internal newsletter *PinUp*, edited and produced by students, offered an opportunity for debate and communication about activities within the department.

CLOSING REMARKS

Our core programs in architectural design enjoyed a successful year with excellent production in the studios and theses. The promotion this year of two of our younger studio faculty to tenure brings a new generation into the core faculty and assures both new energy and stability for this key area. Most needed now is the consolidation of faculty offices and studios, and the provision of resources for faculty development.

Increasing collaboration between studio professors and those in Building Technology (the success, e.g., of newly tenured Andrew Scott in working with BT and the appointment of the young architect John Fernandez to the BT faculty) and special programming create the opportunity for significant teaching and research in several key areas including sustainability.

The new appointments in the Visual Arts Program and the concerted guidance of the group by Dennis Adams establish the promise of a nationally recognized art program. The quality of their space and their equipment are, however, seriously inhibiting to the goals of the group.

The Aga Khan Program will enter upon a new course with the appointment of newly tenured Nasser Rabbat both as Aga Khan Professor and the intellectual director of ArchNet. Rabbat is the most accomplished scholar we have had in this professorship and does bring a professional background to the postion as well. The full realization of this opportunity awaits the completion of Rabbat's sabbatical leave.

The public face of the Department has been enhanced in recent years through innovations in exhibitions, publications, lectures and conferences. Positive factors include our tradition of devoted teaching, a high national ranking of our professional program, and improved (if not yet fully adequate) financial aid. The increasing use of the web as the source of information about institutions and programs has led us to a current redesign of our web site.

More information about the Department of Architecture can be found on the World Wide Web at http://architecture.mit.edu/.

Stanford Anderson

PROGRAM IN MEDIA ARTS AND SCIENCES

For the first time, during 1999–00 academic year the Program in Media Arts and Sciences (MAS) enrolled 14 students in an alternative freshman-year program. These students took special Media Lab recitation sections of core freshman subjects, pursued Media Lab UROP research projects, and participated in two new MAS undergraduate subjects on design and research. We view this program as a first step toward establishing a full-fledged undergraduate program in the future.

EDUCATION

For 1999–00, MAS program received 304 applications, an 11 percent increase over last year. From these, 53 new students (including 10 women) were offered admission: 42 for the master's program, and 11 for the doctoral program. This brought the total MAS enrollment to 131, which included 35 women, 1 underrepresented minority, and 39 foreign students. Of the total, 66 were master's candidates, and 65 were doctoral candidates. Forty-six advanced degrees were awarded during the year (33 SM and 13 PhD). The program offered 32 graduate subjects.

The largest undergraduate presence at the Media Laboratory continued to be UROP students, more than 250 of who participated in research projects at the Media Laboratory. Many of these undergraduates pursued their undergraduate theses under MAS faculty supervision. In addition, the Program in Media Arts and Sciences offered seven undergraduate subjects, and five MAS faculty members and staff conducted freshman seminars or served as freshman advisors.

FACULTY AND STAFF

New appointments

Ted Selker, who has had a close association with the Media Lab for many years as an invited speaker and collaborator, was appointed associate professor and head of the Lab's new Context-Aware Computing group in March. Selker comes to MIT from IBM, where he was an IBM Fellow—the company's highest technical position.

Deb Roy, who recently received his PhD working with Alex Pentland in the Lab's Perceptual Computing group, was named assistant professor in January. Roy heads a new Cognitive Machines research group, which combines aspects of artificial intelligence and cognitive science to develop, implement, and test models of learning, with the overall goal of gaining insights into human cognition.

Promotions

Justine Cassell, head of the Lab's Gesture and Narrative Language group, was promoted to associate professor without tenure. She has been an assistant professor in the Program in Media Arts and Sciences since 1995.

Neil Gershenfeld who has been an associate professor without tenure in the Program in Media Arts and Sciences, was promoted to associate professor with tenure. He heads the Lab's Physics and Media group.

Joseph Jacobson, head of the Lab's Nanomedia group, was promoted to associate professor without tenure. He has been an assistant professor in the Program in Media Arts and Sciences since 1996.

John Maeda, head of the Lab's Aesthetics and Computation group, was promoted to associate professor without tenure. He has been an assistant professor in the Program in Media Arts and Sciences since 1996.

Mitchel Resnick, who has been an assistant professor in the Program in Media Arts and Sciences, was promoted to associate professor with tenure. He heads the Lab's Lifelong Kindergarten group.

HONORS AND AWARDS

Faculty awards

Stephen Benton received the 1999 Dennis Gabor Award from the SPIE, in recognition of his invention of white-light holography and his many other contributions to advancing the field of holography.

Michael Hawley was a finalist and prizewinner in the 2000 Van Cliburn International Piano Competition for Outstanding Amateurs.

Hiroshi Ishii received the Perkins Award for Excellence in Graduate Student Advising presented at the MIT Awards Convocation in May.

Joseph Jacobson was selected by *Technology Review* as one of the 100 young innovators who "exemplify the spirit of innovation in science, technology, business and the arts." In addition, Joe, and his students, were awarded the 2000 Gutenberg Prize for inventions in the areas of printed displays and printed electronics. This prize is awarded once every three years by the German government for innovation and inventions in the tradition of Gutenberg.

John Maeda was one of six designers selected to receive the prestigious DaimlerChrysler Design Award, established in 1993 to celebrate the power of innovation and the blending of art and technology. He was also featured in the December "Genius" issue of *Esquire* magazine, where he was named one of the 21 important people for the 21st century.

Nicholas Negroponte was the 1999 recipient of the Bradford Washburn Award from the Boston Museum of Science. This award is made to an individual "who has made an outstanding contribution toward public understanding of science, its importance, its fascination, and the vital role it plays in all our lives."

Alex Pentland was elected a Senior Fellow of the Design Futures Council.

Rosalind Picard was named a Senior Member of IEEE

The Computer Clubhouse, an innovative after-school program for youths from underserved communities co-founded by Mitchel Resnick, was awarded a $20-million grant over five years by Intel to create an Intel Computer Clubhouse Network across the country—and eventually the world.

Student awards
Benjamin Fry was featured by *ID* Magazine as one of the 40 designers under 30 to watch for the new millennium.

Golan Levin was awarded an Award of Distinction at ARS Electronica in the interactive category for Audiovisual Environment Suite, a collection of five interactive works.

Kimiko Ryokai was the winner of the Computer Support of Collaborative Learning's 1999 Student Paper Competition. Her paper, "Computer Support for Children's Collaborative Fantasy Play and Storytelling," was selected from more than 50 papers submitted.

Marko Turpenien was co-author of "Ontology Development for Flexible Content," which won the "best paper" award for the Internet and Digital Economy track of the Hawaii International Conference for the System Sciences.

When *ID* Magazine announced the results of its annual Design Review earlier this summer, a number of MAS students were recognized. Phil Frei won "best in category" for student submissions for *curlybot*, a toy that records and replays physical motion, exactly mimicking even the subtlest motions you make as you play with it. Golan Levin won a bronze in the art/experimental software category for Audiovisual Environmental Suite. John Underkoffler, a recent Ph.D. recipient, won a bronze in the interactive installation category for Luminous Room. Fernanda Viegas and fellow members of the Lab's Sociable Media group won a bronze—in the Web site category for Chat Circles.

Alex Pentland

DEPARTMENT OF URBAN STUDIES AND PLANNING

Faculty in the Department of Urban Studies and Planning (DUSP) are national and international leaders in planning education and research, providing our students with a unique environment in which to explore cutting-edge city planning and urban development issues. At our Visiting Committee meeting in October, the Department again received glowing praise for our outstanding academic and research programs. However, the Committee identified lack of adequate financial aid for our graduate students as a critical problem for our Department. In addition, we find ourselves at a crossroads, as we anticipate the departure of three junior faculty members next year and two retirements in the near future. Next fall, we will embark on a strategic planning process to address these problems and opportunities. In the meantime, we have launched the Fund for Excellence in Public Service, a loan-forgiveness program for graduates working in the public interest.

RESEARCH AND TEACHING ON URBAN PLANNING

The intellectual life of the Department is organized largely around the activities of the five Program groups, which reflect major areas of current planning practice: City Design and Development; Environmental Policy; Housing, Community and Economic Development; International Development and Regional Planning; and Planning Support Systems (Information Technology). Some highlights of the past year include:

Faculty and students of the City Design and Development Group (CDD) organized and participated in the "Northeast Mayor's Institute on City Design," which hosted eight mayors and an equal number of urban design experts for three days of discussions at MIT. Sponsored by the National Endowment for the Arts, the Institute provides mayors with a forum to present and receive feedback on pressing design issues in their cities. For the first time in the history of the Institute, mayors from two cities outside the U.S., from Catalunya, Spain participated, and the CDD group has been asked by the government of Catalunya to organize a similar Institute there.

Representing the School of Architecture and Planning, the CDD group hosted a session for alumni and alumnae and donors at the Institute's fall Campaign Launch, focusing on the theme of Planning for Cities of Tomorrow. The group also held two special department-wide seminars coordinated with public lecture series. In the fall, "Imagining the New Urban Region in Europe" brought specialists from eight cities across the continent to present innovative approaches to regional design. In the spring, "Housing the City" examined metropolitan-wide experiments in community development in the U.S. and Europe. Papers produced for the group's 1998 seminar on "Imaging The City" will be published in a book by the Center for Urban Policy Research at Rutgers University later in 2000.

The group also sponsored two urban design studios with international venues. The Singapore Studio proposed mixed-use design and development options for a major underutilized site in the center of the city. The Beijing Urban Design Studio, conducted with students and faculty of Tsinghua University, developed proposals for tourism, commercial, and housing development in an historic area near the Forbidden City. The studio is now part of an officially recognized Exchange Program in China that will see a visiting scholar coming to MIT for one semester in the fall. The program is funded by the Asian Cultural Council of New York.

Finally, faculty and students in the group concluded research on "Regional Design and Cultural Development" in collaboration with the Polytechnic University of Barcelona, Catalunya. This project, funded by the government of Catalunya, involved proposals for the reclamation of extensive historic industrial sites as well as agricultural resources in the fifty- mile long Llobregat River Corridor. It culminated in a regional design charrete involving agencies, institutions and property owners that took place in January 2000—the first ever in Catalunya.

The Environmental Policy Group (EPG) hosted a number of distinguished visitors, including Elisabeth Corell, one of the new Wallenberg Post-doctoral Fellows at MIT; Professor Roland Scholz, Chair of Environmental Sciences, Natural and Social Science Interface, Swiss Federal Institute of Technology; and, Dr. Atiq Rahman, Director of the Bangladesh Centre for Advanced Studies. The Environmental Technology and Public Policy Program, with support from the Dutch Government, began work on a multi-year effort to help design procedures for organizing national experiments with greener technologies of various kinds.

With new financial support from the Alliance for Global Sustainability, EPG also initiated a series of comparative studies focusing on regulatory strategies that might help to encourage sustainable development in various parts of the world. EPG faculty facilitated a campus-wide initiative exploring the scientific and political controversies surrounding the introduction of "genetically modified organisms" in various parts of the world. The group also launched an environmental justice initiative that includes both teaching and research activities. Several new courses have been added on this important topic. With a great deal of help from a number of graduate students, EPG has modified its curriculum—adding a series of methods modules and several courses dealing with brownfields redevelopment, environmental leadership, and industrial ecology.

The Housing, Community and Economic Development (HCED) group has continued to focus on how urban neighborhoods respond to the devolution of federal policy and the decreasing demand for low-skilled labor. These issues were explored in a weekly speaker series, which concentrated on workforce development and community organizing initiatives. Through Lecturer Karl Seidman's class, students completed their third consecutive year of economic development planning in Lawrence, Massachusetts. This spring, the class worked with DUSP alumni/ae at the Lawrence Planning and Neighborhood Development Corporation, a non-profit community development corporation, to prepare a Latino business development strategy. The strategy drew upon regional economic and local market analysis, industry research and an assessment of local institutional capacity to recommend a more comprehensive set of initiatives to expand the economic potential of the city's dynamic Latino business community. HCED is also working with Boston's Main Streets Program, a national model of neighborhood commercial revitalization, to document program outcomes and best practices. This relationship will include a new studio course on revitalizing urban business districts in spring 2001.

The faculty in the International Development and Regional Planning (IDRP) group are involved in six major multi-year research and teaching activities, each involving four to 12 graduate students and/or SPURS (Special Program in Urban and Regional Studies) Fellows. One group is finalizing the results of a large two-year study in nine countries in Africa, Asia, and Latin America in which, through field studies and seminars, they analyzed successful cases of administrative decentralization. Since the spring of 1999, a second group of six Master in City Planning (MCP) students and two faculty have been assisting the World Bank on city-development strategies in Indonesia and the Philippines. They produced reports for the World Bank, and most of the students also wrote theses from the field material. In a third project, a faculty member is assisting the World Commission on Dams to develop a legal and policy framework for assessing the social and ecological impact of large dams. This involves working with staff at the United Nations Development Programme (UNDP) to operationalize human rights in the development process and launching an international research project on globalization and local governance, with a preliminary focus on South Asia. A fourth group of faculty and students are working on issues of social investment, conducting various research projects in Northeast Brazil. This long-term research project combines extensive field research by Ph.D. and MCP students with seminars held during the academic year related to the research. A fifth group working in the People's Republic of China (China) is comprised of two cross-disciplinary teams of faculty and students from the IDRP group in DUSP, the Chemical Engineering Department, and the Technology, Policy, and Planning Program at MIT, who are working on energy conservation and pollution-reduction projects in the coke-making sector in Shanxi Province. The collaborating group of physicists, chemical engineers, operations researchers, and political economists are from institutes in Switzerland, Japan, China, and MIT, as part of the Alliance for Global Sustainability. The faculty, students, and technical assistants who work on this project were recently filmed by Chinese TV as part of a program stressing how U.S. academic institutions (in this case, MIT) function. The final sixth group of one Ph.D. and five MCP students are working with faculty members to study means of promoting good governance in the water and sanitation sector in South Asia, with particular emphasis on service improvements for the poor. The specific objectives of this project include: documentation of the current status of governance; identification of cases of public water and sanitation agencies in the South Asia region that have been able to make significant improvements in service delivery, accountability to consumers, reduced corruption, and increased transparency; exploration of the design of incentives and reform strategies ("internal drivers") undertaken in all cases to understand how these approaches were designed and implemented, and why they were or were not successful; evaluation of the larger socio-political context in which the reforms were undertaken, to understand the influence of "external drivers" on agencies' ability to adopt reforms; and development of recommendations for promoting good governance in water and sanitation services in South Asia.

The Planning Support Systems (PSS) group has continued its research on appropriate spatial information infrastructure, modeling urban spatial structure, and informing public debate about urban futures. The group's work on interoperable Geographic Information Systems (GIS) has grown with new support from the Open GIS Consortium and the Federal Geographic Data Committee, and work on transportation planning has been augmented through interdisciplinary collaboration with the Department of Civil and Environmental Engineering and the Center for Transportation Studies. The MIT OrthoServer Tools that were developed for facilitating network access to high-resolution orthophotos have become more widely used and have influenced emerging international standards for web mapping. The Boston metro site (http://ortho.mit.edu/) averages more than 10,000 hits per day and is routinely used by design studios and class projects at MIT, Harvard, and other colleges and schools. Other active research areas include modeling urban "respiration" (how land-use planning can affect metropolitan air pollution patterns), welfare-to-work accessibility, land use and transportation interactions, telecommuting impacts on inner-city mobility, urban design assistance, community networking, environmental impact assessment, and representation aides for transportation analysis and collaborative planning. Each of these areas has involved class projects that led to thesis work.

GRADUATE DEGREE PROGRAM ENROLLMENT AND ACTIVITIES

Our graduate programs enrolled 189 students this year. Of the total, 55% were women, 8% were students of color, and 30% were international students. The Department granted 43 MCP, 2 SM, and 10 Ph.D. degrees.

Building on the success of the last couple of years, faculty continued to offer more for-credit offerings during the Professional Development Institute held in the Independent Activities Period (IAP). In addition to Introduction to Computers in Public Management II—required of all first-year Master's students—eight additional for-credit courses were offered this year: Management Fundamentals for Leaders in Non-Profit Organizations; Challenging the Conventional Wisdom About North-South Conflict: A Shared Commitment to Long-Term Sustainability; Examining Development Standards and Requirements: The Pursuit of Alternatives; Community Organizing and the Pursuit of Democracy; Environmental Impact Assessment: Strategies and Methods; Inner City Revitalization: An Alternative Smart Growth Strategy; New and Emerging Technologies for Planners; and, Neighborhoods and Networks. These classes, combined with non-credit offerings, attracted both undergraduate and graduate students from across the Institute, alumni/ae and local professionals.

The Master's in City Planning (MCP) Committee has been working on the development of a one-year mid-career MS program as part of our efforts to diversify departmental degree offerings and increase sources of financial aid for our traditional degree programs. The Committee also extended its efforts in student recruitment, holding open houses in New York, Los Angeles and Atlanta, and developed a recruitment plan for the Department. Finally, the program continued its efforts to support the MCP thesis exercise, developing activities to help students frame thesis topics and encouraging opportunities for applied thesis exercises, such as participating in an urban design studio.

The Ph.D. Committee began a review of the requirements for the five alternative "First Fields" in the Ph.D. general examination. As part of the review, it is collecting data from both current students and recent graduates on areas that require improvement either in course availability or course content. The review should be complete by the end of the fall semester. The Committee is also examining the awarding of teaching assistantships. In the past, students receiving a three-year departmental aid package were required to teach for three semesters. Traditionally, students took most of the three years to pass their general examinations and so scheduling their teaching assignments presented no problems. Increasingly, however, students are taking their general examinations shortly after their second year—in part a response to Ph.D. Committee policies—after which they leave MIT to do dissertation fieldwork. While this is a good result, the byproduct has been a shortage of funded teaching assistants. The program is now considering alternative ways to deal with this issue.

Our graduate students launched a new national refereed journal, *Projections*. The first issue explores the issue of "crisis cities," the topic of a recent graduate seminar and faculty colloquium.

UNDERGRADUATE PROGRAM ACTIVITIES

During 1999–2000, the Undergraduate Committee continued to focus on developing the community of undergraduate majors and integrating them into department-wide activities. On their own initiative the undergraduate majors sponsored a welcome-back trip to Martha's Vineyard at the beginning of the new school year, and working with graduate students organized a joint forum and job fair to discuss graduate school and career options.

During the past year, the Committee turned its attention to the design and maintenance of the undergraduate curriculum. As a result, the undergraduate major has been redesigned into three tracks: Urban and Environmental Planning, Urban Studies, and Urban and Regional Public Policy. As a result of this restructuring the need for several new subjects was identified and we plan to offer at least four new undergraduate subjects in the 2000–2001 academic year.

Continuing the success of earlier study trips to Montreal and London, the Department continued its commitment to offering an annual study trip for undergraduate majors. During IAP 2000, Professor J. Mark Schuster led a study trip to Barcelona in which twelve of our majors participated. For the first time the trip was preceded by a fall seminar introducing the planning and development of Barcelona.

The interdisciplinary Minor in Public Policy, a program for which we share responsibility with our colleagues in the Department of Political Science, is now up and running with its first cohort of students. A revised version of 11.002J, "Fundamentals of Public Policy," was implemented in the fall of 1999, and the new subject, 11.003J, "Methods of Public Policy Analysis," was offered for the first time in the spring of 2000.

Our undergraduates continue to be involved in a wide variety of community-based activities, most notably Alternative Spring Break. The Department has made a commitment to assisting these outside activities of our students in whatever way possible.

In the fall of 1999, the Department welcomed to its faculty Dr. Eric Klopfer, the new director of the Teacher Education Program (TEP). Over the last six years a growing number of MIT undergraduates have completed certification and are now teaching in public middle or high schools across the country. TEP faculty expect to certify, on average, 10 students each year in the future. In numbers, this will put MIT near the top in math and science teacher education among local programs. More information about the TEP program can be found on the World Wide Web at http://web.mit.edu/teacher-ed/www/.

STUDENT AWARDS

Our graduate and undergraduate students received many awards from national and international organizations, the Institute, and the Department.

National and international awards

Ph.D. students and alumni/ae garnered the following awards: Sumila Gulyani won the Association of Collegiate Schools of Planning Barclay Jones Award for Best Dissertation of the Year. The Society for American City and Regional Planning History, 1997–99 John Reps Prize for Best Dissertation went to Thomas Campanella. The Lincoln Institute of Land Policy awarded Dissertation Fellowships to Daniel Serda and Ciro Biderman. Jennifer Johnson received a Department of Housing and Urban Development Doctoral Dissertation Research Grant. 1999 Fannie Mae Foundation Student Travel Awards went to Jennifer Johnson and Vinit Mukhija. Raquel Gomes, Nichola Lowe, and Rodrigo Serrano received Inter-American Foundation Doctoral Field Research Fellowships. Jason Corburn was awarded an Environmental Leadership Program Fellowship and a Harvard Law School, Program on Negotiation Dissertation Fellowship.

Master's students also won many awards, including: La Tonya Green received the American Planning Association Charles Abrams Scholarship Award. An American Association of University Women International Fellowship went to Madhu Malini Raghunath. Ambika Prokop (2000) and Anyeley Dzegede (1999) were chosen for EDAW's Annual Summer Student Program. The American Planning Association, Massachusetts Chapter gave its 1999 Outstanding Planning Award—Student Project Category—Honorable Mention to members of Lecturer Terry Szold's class—Eryn Deeming, Kristen Harol, Adair Smith, and Margaret Super—for the "Burlington Town Center Vision Plan." Lou Baker won a 1999–2000 Hispanic Scholarship. Santiago Garcia-Moreno received a Fulbright-Garcia Robles Scholarship and a MacArthur-Ford-Hewlett Graduate Fellowship. Madeline Fraser, Brandon Mitchell, Tina Pihl, Tunua Thrash, George Samuels, and Manuel Martinez were selected as Department of Housing and Urban Development Fellows, and Lou Baker, Sophia Chong, LaTonya Green, Carolyn Lee, Katrina Simon were selected as Woodrow Wilson/Public Policy and International Affairs Fellows.

MIT Awards

Our students did very well in the MIT awards category as well: Jonna Anderson received the AMITA Award, while Yanni Tsipis won the Boit Manuscript Prize. The Laya W. Wiesner Award went to Cherry Liu and Jonna Anderson won the Ida M. Green Fellowship to a Senior Woman Student. Michael Fischer won the Ralph Adams Cram Award and Ali Shirvani-Mahdavi received a Martin Fellowship and Scholarship from the Martin Society of Graduate Fellows for Sustainability. A Carroll Wilson Award went to Katrina Simon and Farzana Mohamed received an Aga Khan Foundation International Scholarship/Fellowship. Meghan Horl received a Provost Fellowship for Women and Minority Students and a School of Architecture and Planning Harold Horowitz (1951) Student Research Fund Award went to Anthony Townsend. The Department of Architecture gave its Alpha Rho Chi Medal for Service, Leadership, and Promise of Professional Merit to Michelle Apigian and Eric Cahill received the Hugh Hampton Young Leadership Fellowship.

Departmental awards

At its annual Commencement Breakfast, the Department gave the American Institute of Certified Planners, Outstanding Student Award to Joshua Sevin. Laurie Goldman and Brent Ryan won the award for Outstanding Contribution to the Intellectual Life of the Department, while the Departmental Service Award went to LaTonya Green, Carolyn Lee and T. Luke Young. Prizes for Outstanding MCP Theses went to Richard Cho and Benjamin Schonberger. Jeffrey Rapson won the Wallace, Floyd Award for City Design and Dulcy Anderson received the Flora Crockett Stephenson Writing Prize.

ALUMNI/ALUMNAE NEWS

The fall telethon is always a gratifying way to reconnect with our alumni/ae. This year, 19 faculty and student callers contacted 164 alumni/ae, securing 106 gifts and pledges. We also caught up with a number of alumni/ae at receptions we sponsored at the annual conferences of the American Planning Association and the Association of Collegiate Schools of Planning. Local alumni/ae guest lectured in numerous classes, sponsored internships in their organizations and provided career advice to students at alumni/ae forums organized by each of the Program groups.

A number of alumni/ae braved a very snowy Career Day in February, meeting with students and recruiting for job openings in their organizations. Alumni/ae in New York and Los Angeles provided a valuable perspective to open houses for prospective students in those cities. Our semi-annual alumni/ae journal, DUSP@MIT.now, continues to provide an exchange of updates and ideas between the Department and our alumni/ae around the world. In the fall of 2000, we will be launching a major new initiative to further involve our alums in departmental activities and enhance the resources we offer them.

FACULTY ACHIEVEMENTS

Several faculty members won honors, both from national organizations and at MIT: The Center for Public Resources gave its Outstanding Book Award in the Dispute Resolution Field to Professor Lawrence Susskind, Co-editor of *The Consensus Building Handbook: A Comprehensive Guide to Reaching Agreement.* Professor LawrenceVale won the EDRA/Places 1999 Place Research Award for "Three Public Neighborhoods: Assessing Public Housing Redevelopment." The Association of Collegiate Schools of Planning (ACSP) gave its Outstanding Planning Educator Award to Professor Emeritus Lisa Peattie and its Margarita McCoy Award for Outstanding Service to Women Faculty at ACSP Schools to Professor Karen R. Polenske. Assistant Professor Eran Ben-Joseph won the MIT Wade Award.

In faculty development, Associate Professor Timothy Riddiough was granted tenure. Terry Szold was promoted to Adjunct Associate Professor and Karl Seidman was promoted to Senior Lecturer. The Department hosted two Martin Luther King Visiting Professors: Harvey Gantt (joint with Architecture) taught an IAP course on inner-city revitalization and Karyn Lacy offered a course on suburban America. After extensive national searches, the Department is pleased to have selected Keith Hampton to join the faculty as an Assistant Professor of Technology, Community and Urban Sociology. We will also welcome a new senior woman faculty member, Professor Anne Whiston Spirn, who will have a joint appointment in DUSP and Architecture.

INTERNATIONAL CONNECTION

The non-degree Special Program for Urban and Regional Studies (SPURS) hosted twelve Fellows, five women and seven men, from Brazil, China, Czech Republic, India, Nigeria, Russian Federation, Sri Lanka, Taiwan and Venezuela. Their work embraced several fields, including environmental and regional planning, urban design, sustainable development, markets and issues of governance, and strategies of empowerment. In January, the Fellows organized a seminar, "Facing Challenges: People, Market and Cities." SPURS continued with its tradition of Tuesday Luncheon Seminars, where distinguished speakers from cross-disciplinary areas came to share their research and experiences. The last presentation of the series was by Jamil Mahuad, ex-President of Ecuador, who talked about the decision-making process of his administration in the face of severe economic crisis from October 1998 to January 2000.

COMMUNITY OUTREACH

The Center for Reflective Community Practice (CRCP) began its first full year of activities related to its new mission to develop mutually enriching linkages between the resources of communities and MIT. CRCP Fellows for this year came from four Massachusetts communities (Springfield, Roxbury, Chinatown and Central Square) and one national community organization (The Algebra Project). In addition, two individuals whose work has been tied to assisting others in community building joined CRCP as community scholars. The presence of these fellows and scholars resulted in CRCP conducting over a dozen forums and seminars in communities and at MIT. These ranged from an all-day event with residents of Springfield, Massachusetts and a forum on Culture, Community and Technology with Pete Seeger, to the implementation of a web-supported community dialogue with residents of Central Square, and a seminar on using internet radio to support community building.

The center has also been involved in working to level the playing field around information technology. One project involves connecting all of the residents in a Boston housing complex to the Internet and assisting them in creating their own information system. The other involves supporting the development of the over 41 new community technology centers in Roxbury, Massachusetts.

Finally CRCP has provided other linkages for DUSP and MIT. This year, CRCP brought renowned author Francis Moore-Lappe as a Visiting Scholar as she works on rewriting of her groundbreaking book, *Diet for a Small Planet.* Details of all CRCP activities are available at http://web.mit.edu/crcp/.

RESEARCH FUNDING

Faculty raised close to $1 million in new funds for the following projects: Professor Karen Polenske was awarded $347,000 by the National Bureau of Economic Research, Inc. for a two-year project. The study aims to provide useful measures with which to assess the national economic effects of stimulating industry-specific (automobile sector) technological improvements in dimensional variation in automotive bodies and parts. The National Science

Foundation awarded a $50,000 grant to Assistant Professor Eric Klopfer to investigate the educational outcomes of teachers building their own simulations in StartLogo for use by their students. Assistant Professor Jennifer Davis was funded with a $200,000 grant from the World Bank. The research evaluates the keys to good governance and institutional reforms in water and sanitation institutions in South Asia.

Professor Lawrence Susskind received a $108,400 research grant from the Directorate General of Environmental Protection, Government of the Netherlands. The project will focus on the practical problems associated with community-based experiments designed to test new environmental technologies and to help build theory that will explain how to build consensus and learn from such experiments. Professor Joseph Ferreira, Jr. received funding from Geographic Data Technology, Inc. (GDT) for $24,000, and $25,000 from the Open GIS Consortium, Inc. The projects will review Ortho Server tools within the GDT Computing Environment and participation in the Open GIS Web Mapping Testbed databases.

The American Architectural Foundation awarded $44,955 to Professor Mark Schuster for the Northeast Mayor's Design Institute described above. Mr. Thomas Piper received funding from the Gillette Company in the amount of $62,500 in continued support for the MIT Colloquia on the Future of Boston.

For the fifth funding cycle, the Department received $90,000 from the federal Department of Housing and Urban Development to support minority and economically disadvantaged graduate students.

More information about the Department can be found on the World Wide Web at http://web.mit.edu/dusp/www/.

Professor Bish Sanyal

CENTER FOR ADVANCED VISUAL STUDIES

The Center for Advanced Visual Studies (CAVS) offers an art-based platform for collaborations between artists, scientists, and technologists. These are typically built around projects undertaken by resident Fellows, who also conduct seminars and supervise student participation. An emerging mission of the CAVS is the exploration of the digital arts as a common ground for collaborative projects. Our goal is the creation of important art that could not or would not be possible except at MIT.

ACTIVITIES OF FELLOWS AND AFFILIATED FACULTY

Professor Krzysztof Wodiczko (Visual Arts Program) was invited to participate in the Whitney Museum's Biennial (New York), the Venice Biennale, the Kwang-ju Biennale (Korea), and had a retrospective exhibition at the Hiroshima Museum of Contemporary Art (Japan), among many other activities.

Professor Stephen A. Benton received the 1999 Dennis Gabor award from the SPIE: International Optical Engineering Society, in recognition of his invention of white-light holography and other contributions to the medium of holography.

Fellow Seth Riskin received an MIT Council for the Arts grant for the *Eye Dance* project with Senior Fellow Elizabeth Goldring, February 2000. He also received a Dance Umbrella commission award (with Mia Keinänen) for development of a *Light Dance* performance for the *Boston Moves 2001* dance concert, June 2000.

EDUCATIONAL ACTIVITIES

Professors Glorianna Davenport and Stephen Benton (Program in Media Arts & Sciences) conducted a weekly seminar series in the CAVS conference space. The subject, entitled "MAS 879: Experiences in Interactive Expression," brought the artists Natalie Jeremijenko, Christopher Janney, Don Ritter, George Fifield and Perry Hoberman to MIT for a day of meetings with students and faculty. At the end of the semester, an exhibition of student-produced interactive installations was presented at CAVS.

A total of eleven MIT students joined the CAVS as UROPs and graduate Research Assistants during this year.

PERSONNEL

Hisham Bizri joined CAVS as a Fellow, undertaking a long-term project entitled *Here Comes Everybody*, an interactive installation inspired by the writings of Irish novelist James Joyce. Mr. Bizri had previously been associated with the Electronic Visualization Laboratories of the University of Illinois at Chicago.

Seth Riskin also joined CAVS as a Fellow, undertaking further work on his "Light Dance" projects, and various collaborations with Senior Fellow Elizabeth Goldring, who heads the Vision Arts group. Mr. Riskin has previously been a student (SMVS '89) and Fellow at CAVS, and a Fellow at the KHM, Cologne, Germany.

Professor Rebecca Allen, of the Center for the Digital Arts at the University of California at Los Angeles, was a sabbatical visitor at CAVS during the Spring semester.

More information about the CAVS can be found on the World Wide Web at http://cavs.mit.edu/.

S.A. Benton

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

Established in 1979, the Aga Khan Program for Islamic Architecture (AKPIA) at Harvard University and the Massachusetts Institute of Technology is supported by an endowment from His Highness The Aga Khan. The Geneva-based Aga Khan Trust for Culture (AKTC) provides additional funding for various program activities. AKPIA is dedicated to the study of Islamic architecture and urbanism, visual arts, and conservation and rehabilitation in an effort to respond to the cultural and educational needs of a diverse Islamic world. Towards this goal we aim to improve the teaching of Islamic art and architecture, promote excellence in professional research, and enhance the understanding of Islamic architecture and urbanism in light of contemporary critical, theoretical, and developmental issues. We also continually promote the visibility of pan-Islamic architectural, artistic, and cultural heritage.

AKPIA MIT ACADEMIC PROGRAM

Students

Eight SMArchS students participated in the History and Culture Degree Program. Six completed their degree requirements and graduated: Nandini Bagchee (India), T. Luke Young (USA), Sunitha Raju (India), Aslihan Demirtas (Turkey), Nilay Oza (India) and Markus Elkatsha (Egypt). Two are continuing as second year students Bianca Nardella (Italy) and Yasmine Abbas (France/Syria). One SMArchS student in the HTC program, Tamara Corm, completed her thesis under the supervision of Professor Rabbat and graduated in Spring 2000.

Six doctoral students participated in the AKPIA History, Theory and Criticism Program. Kishwar Rizvi completed her dissertation and Maha Yahya, Lara Tohme (currently a Samuel H. Kress Fellow at ACOR in Amman), Panayiota Pyla (who has Kress Fellowship support), and Talin Der-Grigorian are currently writing their dissertations. Newly admitted Ph.D. candidate, Glaire D. Anderson, is researching the architecture of the Islamic and Christian world with reference to Islamic Spain.

Lectures

Aga Khan Professor Nasser Rabbat organized the Fall 1999 series, "Seeing Others, Seeing Ourselves." Invited speakers were: Caroline Williams, College of William and Mary, Irvin Schick, Harvard University, and Aziz el-Azmeh, Columbia University.

Visiting Associate Professor Hasan-Uddin Khan organized the Spring 2000 series, "Contemporary Architecture in the Islamic World." Invited speakers were: Raj Rewal, Architect, New Delhi, Attilio Petruccioli, former AKPIA Director and Associate Professor of Design, School of Architecture, Politechnico di Bari, Farokh Afshar, Associate Professor at the School of Rural Planning and Development, University of Guelph, and Intisar Azzuz, Independent Scholar. The series finished with the Secretary General of the Aga Khan Award for Architecture, Suha Ozkan, presenting, "Validation and Change: The Aga Khan Award for Architecture."

Faculty Research and Teaching Activities

Recently tenured, Associate Professor Nasser Rabbat was appointed the Aga Khan Professor of the History of Islamic Architecture and named Academic Director of the AKTC sponsored ArchNet project. Using copyright-free photos, he is putting three of his courses—History of Cairo, Islamic Architecture and the Environment, Religious Architecture and Islamic Cultures—on the web. The three websites should be completed by Fall 2000. Rabbat delivered the following lectures: "The Visual Milieu of The Counter-Crusade in 12th-13th c. Syria And Egypt," at "The Crusades: Other Experiences, Alternate Perspectives," the 32d Annual Conference held at the Center for Medieval and Renaissance Studies, SUNY- Binghamton; "Citizen Maqrizi: A Forefather of the Modern Narratives on Cairo," at the Center for Middle Eastern Studies, UC Berkeley; and "The Militarization of Artistic Expression in the Medieval Islamic East," at the Dar al-Athar al-Islamiyyah, Kuwait. Rabbat also served as discussant on the panel "Gender, Slavery, and Sexuality in Medieval Islamic Society," at the MESA 33rd Annual Meeting in Washington, DC.

Professor Rabbat is currently working on two books. The first concerns the problems of representation in Mamluk sources and is tentatively entitled, "Shaping the Mamluk Image: The Scope of the Sources." The second is a study on the fifteenth-century Egyptian historian al-Maqrizi and his Khitat book. It is slated for publication in late 2000 and is tentatively entitled, "Historicizing the City: The Significance of Maqrizi's Khitat of Cairo." He is also co-editing the 1999 Kevorkian Lectures at NYU, which will be published under the title "A Medieval Cairo for A

Modern World." He has published numerous essays including: "The Changing Concept of Mamluk in the Mamluk Sultanate in Egypt and Syria," in *Slave Elites in the Middle East and Africa: A Comparative Study,* (eds.) Miura Toru and John Edward Philips (London and New York: Kegan Paul International, 2000); and "The Mosaics of the Qubba al-Zahiriyya in Damascus: A Classical Syrian Medium Acquires a Mamluk Signature," *Aram* 9–10 (1997–1998 [1999]). He contributed several entries for the *Encyclopedia of Islam,* the *Encyclopedia of the Qur'an,* and *A Guide to the Late Antique World* (Harvard, 1999). He also contributed many essays to the Arabic newspapers *al-Hayat, al-Mustaqbal, Akhbar al-Adab, Wughat Nazar* on cultural issues, art, architectural history and criticism, as well as reviews of books, exhibitions, and films.

Professor Rabbat was on sabbatical in Cairo, Egypt, during the spring semester. His sabbatical was supported by a fellowship from The American Research Center in Egypt (ARCE). In Cairo, he gave several lectures on various topics at the following institutions: the American Research Center in Egypt; Ain Shams University, Department of Architecture; the Institut Français d'Archéologie Orientale [IFAO]; the Egyptian Historical Society; and the Department of Arabic Studies, American University in Cairo.

Visiting Associate Professor, Hasan-Uddin Khan conducted his fourth seminar at MIT in the Fall of 1999, "Communities of Resistance: Globalization, Tourism & War," concerning the disruptive effects of tourism and war on urban conservation and historic preservation projects. During the summer of 1999, he delivered a talk on the 20th Century architecture of the Middle East to the International UIA congress of Architecture, as well as a presentation of Charles Correa's work at the VIII Panamian Congress of Architecture. In the fall he was a panelist on the Globalization of Asian Cities at the University of Nebraska—the proceedings of which have been published. In the Spring 2000 semester, Khan conducted a workshop on the University of the Middle East (UME)—a real project to be sited in Morocco. Ron Rubin, UME Vice President and Frank McGuire, Principal Cannon, assisted. The workshop provided a forum for three MArch and three SMArchS-AKP students to work on issues of site selection, sustainability and campus planning. Participating critics and speakers included: architects Bruno Freschi and Mozhan Khadem, former Harvard Dean, Henry Rosovsky, Harvard Law School Professor, Henry Steiner, and numerous MIT Professors. Professor Khan continues writing and researching on issues of historic preservation and contemporary architecture in Asia, with particular reference to Islamic cultures.

Howayda al-Harithy was the Visiting Associate Professor for the AKPIA/HTC Spring 2000 semester. Her seminar, "Issues in Islamic Urbanism: Politics of City Formation and Transformation in the Muslim World," investigated issues such as the conception vs. perception of cities, patterns of urbanization, urban morphogenesis, the model of the "Islamic City," and the visual representation of cities. Receiving her Ph.D. from Harvard's Fine Art Department in 1992, she has held a position in the Department of Architecture and Design at the American University of Beirut since 1994. She was the Aga Khan Visiting Scholar at Harvard during the Summer of 1999. Specializing in Mamluk architectural history she recently published, "The Patronage of al-Nasir Muhammad ibn Qalawun" in *Mamluk Studies Review* 4 (2000). This year, she has published a monograph with the Orient-Institut der Deutschen Morgenlåndischen Gesellschaft titled *The Waqf Document of Sultan Hasan ibn Muhammad ibn Qalawun, dated 760/1358.*

Library Resources

Librarian Omar Khalidi was invited to the Georgetown University Center for Muslim-Christian Understanding for the seminar on "Muslim Community's Role in American Public Life" in September, 1999. The United States Information Service in Pakistan and Kuwait invited him to show an exhibition on designed mosques in the United States in early 2000. He also lectured on this topic at the Department of Architecture, University of Engineering and Technology in Lahore, at the American Center in Islamabad, Sindh University in Hyderabad, Faisalabad University in Faisalabad, as well as to the Kuwait Engineers Society and to the Kuwait Journalists Union. In April he lectured on the same topic at DePaul University's spring-long series "Exploring Muslim Cultures," supported by the Graham Foundation. He also spoke on Islam in America at Wellesley College sponsored by the Al-Muslimat student organization.

Visual librarian Ahmed Nabal was a consulting archivist to the MIT ArchNet project. In April 2000 he attended the annual meetings of MESA and the Visual Resources Association in San Francisco. He expanded web availability of the visual archives. Nabal also expanded and enhanced several database files in the archives including those for the central collections, student travel grants and Aga Khan Award for Architecture (AKAA). He worked with the MIT Libraries systems office to move and consolidate images and records onto a single MIT Libraries server

(http://bloom.mit.edu/). Additions to the archives include 533 slides of significant Iranian monuments in Kashan, Isfahan, Hamadan and Kerman by AKPIA student Mona Fawaz. Nabal organized the Rotch Library exhibit of AKAA awards on display throughout the summer of 1999.

AKPIA HARVARD ACADEMIC PROGRAM

Students

Three Harvard/AKPIA students were awarded Ph.D. degrees in June 2000: Alka Patel, Oya Pancaroglu, and Ahmet Ersoy. Two undergraduate senior theses were awarded to: Lama Jarudi and Jessamyn Conrad.

Lectures

The Fall 1999 Friends of Islamic Art lecture series hosted: Barry Wood, Independent Scholar, and Nuha N.N. Khoury, University of California, Santa Barbara, and Aga Khan Program Postdoctoral Fellow.

The Spring 2000 series hosted: Robert Ousterhout, School of Architecture, University of Illinois; Yasser Tabbaa, Independent Scholar; Lorenz Korn, Aga Khan Program Postdoctoral Fellow, Harvard University; and Thomas Leisten, Dept. of Art and Archaeology, Princeton University.

Faculty Research and Teaching Activities

Aga Khan Professor of Islamic Art and Architecture Gülru Necipoglu continues work on her book, *Architectural Culture in the Age of Sinan: Decorum, Identity and Memory*, to be published by Reaktion Books. She plans to complete the work in 2001-2.

In addition to her teaching responsibilities she gave guest lectures in two team-taught courses in the Near Eastern Languages and Cultures Department. On a travel grant from the Palace Arts Foundation she took her core course students to the exhibition "Palace of Gold and Light: Treasures from the Topkapi Palace, Istanbul" at the Corcoran Gallery of Art in Washington D.C. Additional funding was provided by Harvard/AKPIA.

She was a key participant in an international roundtable workshop which planned the exhibition *Portraits of Ottoman Sultans*, which opened June 7 at the Topkapi Palace in Istanbul. Her article "Word and Image: The Serial Portraits of the Ottoman Sultans in Comparative Perspective," appeared in a bi-lingual (English/Turkish) exhibition catalogue. The catalogue also includes her essay on the Portraits of Sultan Selim II. Other publications included a Spanish version of her earlier article "Suleyman the Magnificent and the Representation of Power in the Context of Ottoman-Hapsburg-Papal Rivalry" (originally published in *The Art Bulletin*, Sept.1989) for the catalogue of the recent exhibition *Carlos V. Las Armas y Las Letras* at the Alhambra, Granada, Spain.

Lectures delivered included "Monumental Calligraphy in Classical Ottoman Architecture: Transformations in Form and Content" at the Sackler Museum in October 1999, "Art, Empire, and Tradition: the Ottoman Achievement" and "Monumental Calligraphy in the Early Modern Islamic World: Legibility and Meaning" in December 1999 at the University of Michigan, Ann Arbor. Professor Necipoglu continued as Editor of *Muqarnas*. She also served on the editorial board of *RES: Anthropology and Aesthetics*.

Professor David Roxburgh began his sabbatical in July 1999 receiving partial support from a J. Paul Getty Postdoctoral Fellowship. He was also awarded an ARIT-NEH postdoctoral fellowship. During his sabbatical he wrote a book-length study of album-making titled, "In the Realms of Dispersal and Collectedness: Art and Aesthetics in Pre-Modern Iran." He completed a study on the album preface genre to be published in the AKPIA *Muqarnas* supplement series entitled "Prefacing the Image: The Writing of Art History in Sixteenth-Century Iran" which will be published in late 2000. In addition to lecturing at the LA County Museum, Los Angeles (Ancient Art Council), he also gave one of the Daniel H. Silberberg lectures at the Institute of Fine Arts, NYU, presenting new research on 15th-century anthologies.

In Fall 1999, he was guest editor of an issue of *Muqarnas* 17 (2000). An introductory essay as well as his study on the artist Kamal al-Din Bihzad and authorship in Persianate painting was included in this issue. He completed two articles: "The Pen of Depiction: Drawing in 15th- and 16th-century Iran," *Harvard University Art Museums Bulletin* 8, 1 (Fall, 2000); and "Au Bonheur des Amateurs: Collecting and Exhibiting Islamic Art, ca. 1880–1910," *Ars Orientalis* 30 (2000). He also wrote entries for an exhibition catalogue to honor collector John Goelet (*Forty Years On: Donations by John Goelet*, exhibition catalogue [New York: M. T. Train/ Scala Books, 2000], cat. nos. 152,

153, 158, 159–63). This spring he finished, "The Aesthetics of Aggregation: Persian Anthologies of the Fifteenth Century," for *Princeton Papers: Interdisciplinary Journal of Middle Eastern Studies*, special edition *Seeing Things: Textuality and Visuality in the Islamic World*, eds. Oleg Grabar and Cynthia Robinson (Princeton: Markus Wiener Publishers, 2000).

Library Resources

The Fine Arts Library had a number of notable acquisitions and renewed their in-class bibliographic instruction unit on resources for the study of Islamic visual culture. As part of its outreach activities, the AKP Documentation Center contributes indexing for Islamic architecture, art, archaeology, and urbanism for Index Islamicus, the leading bibliographic research tool in the field.

Jeff Spurr, who catalogues Islamic Art at the Aga Khan Documentation Center, became a member of the VIA Data Standards Committee, continuing the development of Harvard's online catalogue of visual collections. He was also appointed a member of the OLIVIA Sites Subcommittee, establishing procedures and guidelines for automated cataloguing of architecture. He composed the web page for the Harvard Semitic Museum Photographic Archives found on the Fine Arts Library's website. He is responsible for a major acquisition of 26 rare photographs of Jerusalem and Cairo taken by James Graham between 1855–57. He was active in the ArchNet Development Group and continued his work coordinating the Bosnia Library Project. He initiated the solicitation of donations to restore the destroyed slide collection of the Faculty of Architecture of the University of Sarajevo. With Andras Riedlmayer, he coordinated the visit of Ahmet Gerguri, Director of the National and University Library of Kosovo, to Harvard.

Andras Riedlmayer, Bibliographer in Islamic Art and Architecture launched the Kosovo Cultural Heritage Survey in the summer of 1999. Supported by a grant from the Packard Humanities Institute (PHI), Riedlmayer, Andrew Herscher, and Genc Samimi, Director of the Atelier for the Protection of Cultural Monuments in Albania, spent three weeks in Kosovo documenting the state of cultural and religious heritage in the aftermath of war. The resulting documentation—more than 2,000 photographs, architectural plans, and texts—will be made available in database form on the ArchNet website. Riedlmayer organized the exhibition, "Burned Books and Blasted Shrines: Cultural Heritage under Fire in Kosovo," at the Harvard Fine Arts Library April–July 2000, which was featured in the July–August 2000 issue of the *Art Newspaper* (London). Riedlmayer and Herscher also organized the first projects for protecting and reconstructing damaged historic buildings in Kosovo.

AKPIA CENTRAL OFFICE REPORT

In addition to its regular duties, the Central Office provided start-up assistance to the AKTC funded, and MIT-based, ArchNet project. Organizational support was provided to Aga Khan Professor Nasser Rabbat and Visiting Professors Hasan-Uddin Khan and Howayda al-Harithy for their invited lecturers, students, and AKPIA related professional/academic outreach activities.

MIT/AKPIA Summer 2000 Travel Grants were awarded to three students. In addition, travel awards were given to two students to enable them to participate in the Mostar 2000 Workshop.

AKPIA conference proceedings, *Rethinking the 19th Century City*, and *Bukhara: The Source, the Myth, the Architecture and Urban Fabric*, appeared in print in the second half of 1999. The fourth, and last, conference proceedings, *The Courtyard House and the Urban Fabric* was sent to the editors for final preparation. In late Spring 2000 the 20th Anniversary AKPIA Newsletter was printed and distributed to 2000 recipients worldwide. Supported by AKTC Grant "Outreach Activity" funds *Muqarnas 16* appeared in Fall 1999, edited by Prof. Gülru Necipoglu. *Muqarnas Supplement 8*, "The Garden of Mosques: Hafiz Huseyin al-Ayvansarayi's Guide to the Muslim Monuments of Ottoman Istanbul," edited, annotated and translated by Howard Crane appeared in Winter 1999.

AKPIA supported MIT student participation in the Adapazari workshop, a project for the development of socially and environmentally sustainable housing for victims of Turkey's 1999 earthquake. Working in the past with students on sustainable development projects in Latin America, China, and the Hunza Valley of Pakistan, MIT Professor Jan Wampler led a workshop which demonstrated how small scale communities can use appropriate sustainable development within local cultural, environmental, seismic and economic constraints. Istanbul presentations served to develop a final design framework and seek material and financial support for implementation in summer 2000.

The MIT School of Architecture received support from the Trust for Mutual Understanding for *Interpolations: New Housing Designs for Post-War Bosnia-Herzegovina.* Evolving out of the 1997–1999 AKPIA/Sarajevo Reconstruction Initiative, the project will utilize remote-site technology to design contemporary housing that will complement Sarajevo's urban fabric, historical patrimony and built environment. Deans and faculty from the University of Sarajevo, Yildiz Technical University, Istanbul, and MIT will guide student teams. Slated to begin in the fall of 2000, AKPIA is still seeking institutional gifts to match the TMU grant to support student travel for on-site workshops.

AKPIA sponsored the Harvard Center for the Study of World Religion May symposium "Reinterpreting Shamanism: New Criteria for Research and Analysis" and a MIT Muslim Students Association's public lecture "Order and Balance in Islamic Architecture" by Dr. Sami Angawi.

More information about is program can be found on the World Wide Web at http://web.mit.edu/akpia/www/AKPsite/.

Nasser Rabbat

CENTER FOR REAL ESTATE

The Center for Real Estate (MIT/CRE) was founded in 1984. The mission of the center is to improve the quality of the built environment through education and research and by facilitating communication among members of the real estate industry worldwide. To this end, it carries out research and teaching programs in the field of real estate development, investment, and management. It also provides a forum for the exchange of information and the discussion of issues by real estate professionals from around the world. The center's principal activities include an 11-month professional degree program leading to a Master of Science in Real Estate Development and a research agenda of issues relating to the planning, development and management of real estate, including its financial performance.

EDUCATION

Thirty members of the Class of 1999, the fifteenth class of MSRED graduates received their SM degrees in Real Estate Development in October, 1999. Three more students completed their requirements and received their degrees in either February or June of 2000 and a fourth student is expected to complete his thesis and graduate in September with the Class of 2000. The 35 members of the incoming Class of 2001, which includes four joint degree candidates, were selected in March from an applicant pool which was strong though somewhat smaller than last year's. The new class of four women and 31 men includes 11 international students. Ten incoming students already hold advanced degrees in business, architecture, civil engineering, planning or construction management.

The center is fully supporting one ongoing Ph.D. candidate jointly in the Departments of Economics and Urban Studies and Planning.

There were no major changes to core courses this year, though course content continues to evolve as the real estate industry changes, particularly in the area of finance and real estate capital markets. A program requirement for MSRED candidates, finance theory, previously taught in a single term, is now taught as a two-term course beginning with Course 15.401, Finance Theory I.

RESEARCH

Center faculty are engaged in a number of research projects. Professor of Economics William C. Wheaton is analyzing the relationship between regional wages and urban agglomeration. Timothy J. Riddiough, newly tenured Associate Professor in the Department of Urban Studies and Planning, is doing a study for HUD on how informational advantage by Fannie Mae and Freddie Mac affect the cost and availability of mortgage finance for consumers. He is also studying the demand for commercial real estate, focusing on the determinants of asset prices, particularly the feedback between supply and demand, as well as non-standard risk effects. Henry Pollakowski, visiting scholar in the Department of Urban Studies and Planning, is concluding a study of the Bermuda housing market for the Bermuda Housing Corporation. He is also engaged in building a simulation model, jointly with the Center for Urban Land Economics Research at the University of Wisconsin, which projects state sales tax losses stemming from internet retail growth. This research is supported by the International Council of Shopping Centers.

Professor Riddiough published some of his recent work on the commercial mortgage-backed securities market as a working paper entitled "Forces Changing Real Estate for at Least a Little While: Market Structure and Growth Prospects of the Conduit-CMBS Market." That study analyzes the structure and economics of the conduit-CMBS market and assesses its potential for short and long-term growth.

For a fourth year, the center hosted visiting scholar, Henry Pollakowski, housing economist and editor of the *Journal of Housing Economics.*

PROFESSIONAL EDUCATION

The fifteenth summer of professional development courses brought 452 attendees to campus in June and July of 1999, a 16% percent decrease from the previous summer's record high attendance. Attendees enrolled in nine courses, including one new course, an "Introduction to Portfolio and Asset Management," which was very well received. Enrollment in the center's 2000 Summer Institute courses was running well below 1999 figures at the end of June. There were two new courses in 2000: one on green development taught by William Browning '91, an MSRED alumnus, and one on structuring complex transactions taught by Columbia Professor Lynne Sagalyn, who formerly taught at MIT.

MEMBERSHIP

Income from membership remained steady as the center closed the year with 91 supporting members (including seven international members). This represents a net gain of 12 over the previous year, however many of the new members were designated as a result of their contributions to the Alumni Fund. The center added seven new members in the regular way and lost the same number in 1999–2000. In addition to annual fees, many members supported the center in non-financial ways by providing case study sites, lecturing in class, and supporting student thesis work. For a fourth year, Robert Danziger, retired Chairman of member firm Northland Investment, organized and led the well-received Real Deals speaker series.

The 15th anniversary of the center's founding was marked by a September symposium, "Real Estate in a Global Economy," which was attended by more than 300 alumni, members, and friends. It featured economist and Visiting Professor Roger Brinner, and Epoch Foundation Professor of Management, Donald Lessard speaking on hot economies and hot money. They were complemented by a number of distinguished speakers from the center's member firms in the real estate industry, including James Didion, Chairman of CB Richard Ellis; Bernard Winograd, CEO of Prudential Real Estate Investors; and Richard Clarke, CEO of Lend Lease Development, US. The symposium was followed by a dinner for members at which the center recognized two alumni. David Marvin '94 received the Spaulding Award for his pioneering hotel project in downtown Atlanta, and Erin O'Boyle '85 was commended for her effective leadership of the Alumni Fund Drive.

The center also hosted a lively and well-attended members meeting in May for corporate supporters, current students, and faculty. The topic of the meeting was the impact of e-business on the real estate services industry. The dinner speaker, William Mitchell, Dean of the School of Architecture and Planning, set the scene with his presentation "Urban Patterns and Cyberspace." The following morning a group of e-business entrepreneurs presented their business plans while a panel of academics, including Professor William C. Wheaton and Visiting Associate Professor James Short, and industry representatives commented on the presentations.

ALUMNI CAPITAL CAMPAIGN

In connection with the 15th anniversary, alumni of the MSRED program raised a total of $668,756 with their participation reaching 66%. Another $70,000 was pledged to be paid over the next two years. The funds were used to establish the "MIT/CRE Alumni Fund for Excellence in Education" which will be used for scholarships, special projects, and funding for Ph.D. students and visiting faculty.

To celebrate their efforts, the alumni held a "Gala Event" in October which was attended by several hundred alumni and spouses along with faculty and staff. Chancellor Lawrence S. Bacow, the center's first Director of Education and a long-time teacher, mentor and friend to alumni was recognized for his many contributions to the center.

ADMINISTRATION

Chairman Blake Eagle, Director, Professor William Wheaton and Associate Director, Marion Cunningham continued in their posts this year. Blake Eagle will be leaving in December after seven years at MIT. A search for his successor is under way and an announcement is expected in the fall.

The renovation of the Blakeley Lecture Hall was substantially complete by the time classes started in the fall; however, the new computer projection system was not fully operational until the start of spring term. The work was paid for from the center's accumulated operating surplus and from the Alumni Fund for Excellence in Education.

Information about center programs is published on the web at http://web.mit.edu/cre/www/. This is also the primary source of inquiries by the public about the MSRED program, professional development courses, and working papers. Additions to the site this year include an expanded alumni page listing the Alumni Association of the Center for Real Estate (AACRE) directors and events, and an online update form for alumni addresses and news.

William C. Wheaton

MEDIA LABORATORY

For the Media Laboratory, 1999–2000 has been a banner year for new projects and new directions, both at MIT and abroad. In May, the Lab announced a 10-year collaboration with the Republic of Ireland to establish MediaLabEurope (MLE) in Dublin. This independent, university-level educational center is the culmination of several years of negotiation with the Irish government, and represents the first time that the Media Lab will attempt to replicate its unique research culture away from the MIT campus. During its first eight years of operation, MLE expects to grow to a community of 20 faculty members and 35 full- and part-time research staff, with first collaborations focusing on learning and education, arts and expression, and e-commerce. To facilitate the free exchange of information, the Media Lab and MLE will share all intellectual property developed over the initial 10-year period.

Back in Cambridge, the Lab has been moving ahead with plans for a new seven-story complex that will roughly double the size of its current space. The new building, which will be adjacent–and connected–to the current Media Lab, will house the Okawa Center for children, learning, and developing nations. It will also house two additional centers: one focused on the underlying science and technology needed to merge the bits of the digital world with the atoms of the physical world; and a second focused on arts and expression. The new building, being designed by Pritzker Prize winner Fumihiko Maki, is scheduled to be completed in 2003.

The challenge for the next several years will be for us to undertake these ventures without slipping into the mainstream—holding on to the counter culture and "outlandishness" that have defined the Lab to this point. We have often said that being different is hard, but we may find that staying different is even harder.

RESEARCH ACHIEVEMENTS

A sampling of 1999–2000 Media Laboratory research accomplishments includes:

An innovative way to use atomic force microscopy to create "write-once" ***terabit-per-square-inch data storage***–like a CD, but capable of holding 5,000 times as much information in the same space.

Nami, a decentralized, distributed network of orbs that display a wave-like wash of color by communicating with each other. This could become the model for localized networks for everyday household use, where all your consumer products become "nodes" that integrate themselves into a single network with minimum effort.

A ***smart kitchen counter***, which has been augmented with an overhead projection system and sensing device. While a Web page with cooking instructions is projected onto the counter, a hidden sensing device allows the counter to "know" where the cook's hands are, responding with appropriate instructions.

A new technology to mass produce ***super-cheap transistors*** by printing them directly onto a plastic substrate using a solution of cadmium selenide nanocrystals.

Expressive Footwear (sneakers to be exact) that sport a wireless suite of sensors, microcomputer, and data link that measure more than a dozen different parameters of motion and feed this information wirelessly into a PC, which uses a unique program to turn the movements into sound.

Tradable bits, called ***i-balls*** (information balls)—simple computer programs, such as an animation or game, that kids can create, carry around, modify, and trade with one another by using small, hand-held and wearable computers (i-sockets), opening up a new world of digital interaction in the schoolyard, bus, or neighborhood.

Reputation agents that help take some of the risk out of online transactions–rewarding reputable customers with lower prices, and making it more difficult for unreliable buyers and sellers to participate in e-commerce.

Wireless "***digital town centers***," capable of providing even the most remote and underdeveloped areas of the world with telephone, e-mail, and Web access. The centers are designed to bring new forms of medical care, education, entertainment, and commerce to remote areas.

Affective computing, which will give "emotional intelligence" to computers, making them more "reasonable" when it comes to interacting with people. Tomorrow's affective computers will be able to sense what delights or frustrates you, or even figure out if it's a good time to interrupt.

Wearable computing, which allows us to move beyond PCs and laptops and wear our computers as we would eyeglasses or clothing. One collaborative project with the San Francisco Museum of Modern Art involves a wearable computer that adds a layer of audio-visual narrative to a visitor's trip through an art gallery.

Expressive ***synthetic characters*** that inhabit virtual environments and interact autonomously in response to users' actions, appearing to have minds of their own.

New ways of joining the physical environment and cyberspace by making ***"tangible bits"*** accessible through everyday physical surfaces like walls or desktops, and eventually through household surfaces like refrigerator doors.

A new class of ***low-cost, wireless sensors*** that can be used to bring digital functionality to low-cost consumer products. An example would be a 5¢ wireless temperature sensor that could be embedded in cookware or packaging for food or medicine.

Audio Spotlight, which uses ultrasound to project audio to highly specific locations, so that a person standing only a few feet away from someone else can be listening to an entirely different broadcast, with no distraction.

More effective, meaningful ***online news services***. These range from Time Frames, a tool to make online news more relevant by augmenting a general news source with small amounts of information specific to the reader, to Brico, a computer knowledge base that understands the meaning of words to create "sense tagging" for multilingual translations.

SPONSORS

Research sponsors

In Fiscal Year 2000, the Media Laboratory's total sponsor volume reached $30.5 million. Corporate sponsors gave over $28 million (92%). The remaining $2.5 million came from government funding and subcontracts with other universities.

New directed research sponsors included: ATR, which supported Professor Alex Pentland and his Perceptual Computing group; Lucent Technologies, which supported Professor Mitchel Resnick's work with the Boston Youth and Community Connections Program; Intel Foundation, which provided a grant for Professor Resnick's work with the Intel Computer Clubhouse Network; and Sega Enterprises, which provided a grant to support Professor Tod Machover's Toy Symphony project.

Corporate research partners

Intel Corporation, a long-time sponsor, and two new sponsors, the United States Postal Service and eircom, have recently joined the Media Laboratory at the Corporate Research Partner level. Corporate Research Partner status gives these companies membership in all of the Lab's consortia and special interest groups.

Consortia

New sponsors joining the Lab's other consortia include:

Digital Life
Charmed Technology, Frontline, Harman International Industries, Ltd., Masco Corporation, McDonald's, Merrill Lynch, Royal Ahold nv, Try Group, Inc., Viant Corporation and Zkey.com

News in the Future
OneMain.com

Things That Think
Agilent, Amgen, Center for Future Health/University of Rochester, Chevron Information Technology, Daimler Chrysler, International Paper Company, Kaiser Foundation Health Plan, Inc., Lear Corporation, Marks & Spencer plc, Mars, Inc., NCR Corporation, Saab AB, Schott Glas, Shell Oil Company, and Sun Microsystems

Special interest groups

One new special interest group, *e-markets*, was established in Fiscal Year 2000. This group focuses on new forms that transactions may take in a networked world, and explores the new social and economic order that may result.

SPECIAL FUNDS

Several of the Laboratory's most generous sponsors continued to support the Laboratory through corporate fellows programs. In total, twelve corporations supported fellowship programs during FY'00.

Four sponsors, eircom, LEGO, McDonald's and Toshiba, funded new fellowship programs, while BT, Chanowski (Origin), IBM, Interval Research Corporation, Merrill Lynch, Mitsubishi Electric Research Laboratories (MERL), Motorola, and Telecom Italia continued ongoing programs, supporting the following fellows:

BT: Brian Clarkson, Vanessa Colella, Kai-yuh Hsiao, F. Joseph Pompei, Nitin Sawhney, and Jim Youll.

Chanowski (Origin): Tom White.

eircom: Constantine (Dean) Christakos, Daniele De Francesco, Aisling Kelliher, Maggie Orth, Jonah Peretti and James Jung-Hoon Seo.

IBM: Ari Adler, Michael Best, Benjamin Fry, Vadim Gerasimov, Jeremy Levitan, Yael Maguire, Bakhtiar Mikhak, Ravikanth Pappu, Brygg Ullmer and Sunil Vemuri.

Interval Research Corporation: Mike Ananny, Erik Blankinship, Karrie Karahalios, Pengkai Pan.

LEGO: Phil Frei, Saul Griffith and Claudia Urrea.

McDonald's: LaShaun Collier, Wendy Ju and Daniel Stevenson.

Merrill Lynch: Ta-gang (David) Chiou, Golan Levin, Bradley Rhodes, and Sybil Shearin.

Mitsubishi Electric Research Laboratories (MERL): James Patten.

Motorola: Rick Borovoy, Emily Cooper, Rich Fletcher, Cameron Marlow, Stefan Marti, Robert Poor and Matthew Reynolds.

Telecom Italia: Natalia Marmasse, Joan Morris, and Adam Smith.

Toshiba: Ari Benbasat, Rich DeVaul and Ali Mazalek.

NEW LABORATORIES

To help finance the new Media Lab complex, we are establishing a number of named laboratories.

In October 1999, the Media Laboratory announced a $5-million grant from Swatch, Ltd. to establish the Nicolas G. Hayek Swatch Laboratory. The new lab will focus on the design and invention of artifacts and systems that contribute to improving the quality of life in a wide range of consumer-oriented domains, such as wearables, telecommunication products, and automobiles.

The Lab also announced a grant totaling more than $5.6 million from MasterCard International to establish the MasterCard Future of Transactions Laboratory and research fund. The MasterCard Laboratory will explore the new forms that transactions, including payment transactions, may take in a networked world, and will examine the new social and economic order that may result from these changes.

In December, the Lab announced a $6-million grant from Telefonos de Mexico, S. A. (Telmex) to establish the Telemex Laboratory for Information Technologies and to support Telmex fellows. This new laboratory will provide a focus for the Media Lab's work in communications and development, and will reflect a mutual commitment to meaningful technological innovation, specifically in developing solutions that are technologically and economically well suited to the Mexican, North American, and Latin American markets.

The Media Lab also announced a BT Laboratory, established through a grant in excess of $6.5 million from BT. The new lab will allow BT and the Media Lab to work together to pursue new applications in mediated communications.

All four new laboratories will have temporary homes in the Wiesner building, and will be relocated to the new Media Lab building when it is completed.

GIFTS OF EQUIPMENT

In Fiscal Year 2000, the Media Laboratory received over $360,000 in equipment from the following companies: Compaq, Intel, Nortel Networks, and Symbol Technologies.

PERSONNEL

New appointments

Michael Schrage joined the Laboratory as co-director of the *e-markets* special interest group. A former research affiliate of the Media Laboratory, Schrage is a Merrill Lynch Forum Innovation Fellow, has written several books, and has served as a contributing editor and columnist for several newspapers and journals.

The facilities group at the Media Lab welcomed four new staff members this fiscal year: Kevin Davis and Mathew Tragert joined as facilities coordinators; Jan De Kenis joined as an administrative staff assistant, replacing Sandra Gordon who left the Lab to relocate to Spain; and John DeFrancesco, who brings 20 years of previous MIT experience to the Lab, joined as a fabrication resources coordinator.

The Lab also made several research staff appointments during 1999–00: Bakhtiar Mikhak was appointed research scientist in the Epistemology and Learning group for three years, beginning in June; Warren Sack was appointed research scientist in the Epistemology and Learning group for six months, beginning in March; and Timothy McNerney was given a three-month (February through April) appointment as a research specialist in the Context Aware Computing group. Elisabeth Sylvan was given a one-year appointment as empirical studies manager for the Gesture and Narrative Language group, beginning in April.

The Laboratory appointed six new technical staff members during the past year: Chi Yuen joined as Unix systems administrator in October, replacing An Ho who left the Laboratory after 11 years to relocate to California. Jeannie Finks joined as web designer/content manager in October 1999. Trevor Schroeder joined as systems administrator in January, replacing Fred Donovan who left the Lab to accept another position at MIT. Noah Fields joined as systems programmer in May, replacing Jon Ferguson who left the Lab to join a start-up software company. Michael Ratta joined as network engineer in April, replacing William Glesnes who left the Lab to join a start-up software company. Tanya Pfeffer joined the Laboratory as an administrative computing support specialist in May.

New visitors and affiliates

Tetsuro Chino from Toshiba Corporation was appointed as research affiliate in the Vision and Modeling group from January 1, 2000 to December 31, 2000.

Barry Kort and Robert Reilly were appointed part-time visiting scholars in the Affective Computing group from May 1, 2000 to April 30, 2002.

Charles Doria from the US Postal Service was appointed as research affiliate in the Physics and Media group from April 1, 2000 to March 31, 2003.

Arthur Tauder was appointed as visiting scholar in the News in the Future Consortium from April 1, 2000 to March 31, 2001.

Promotions

Several administrative assistants were promoted to staff during 1999–00: Chad Brustin was promoted to project coordinator for the Arts and Expression group; Joanne Broekhuizen was promoted to executive assistant to Bruce Bullock, the managing director of the Media Laboratory; and Greg Wiberg was promoted to contract administrator in the Finance and Administration group

Resignations

Two members of the Lab's finance staff left during Fiscal Year 2000: Sarah Brady, who served as senior financial administrator for the past three years, left to accept another position at MIT, and Melissa Yoon, who was a fiscal officer, left to explore other career options. Other departures included Dennis Irving, facilities coordinator, who left the Lab to relocate to Florida, and Michael Genrich, administrative computing support specialist, who left to join a start-up software company.

More information about the Media Laboratory can be found at http://www.media.mit.edu/.

Nicholas Negroponte

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Intel
International Business Machines
The LEGO Group
McDonald's Corporation
Merrill Lynch
Mitsubishi Electric
Motorola, Inc.
SEGA
Sony Corporation
Telecom Italia
Telmex
Toshiba

SPECIAL INTEREST GROUPS
Broadercasting
Compaq Computer Corporation
Eastman Kodak
McCann-Erickson Worldwide
Warner Bros.
CC++
DaimlerChrysler
Ford Motor Company
General Motors
Lear Corporation
Counter Intelligence
Best Buy Co., Inc.
Kraft Foods, Inc.
Marks & Spencer, plc
Masco Corporation
McDonald's Corporation
Merloni Elettrodomestici
Royal Ahold
Unilever
e-markets
Acer Incorporated
BellSouth IntelliVentures
Chevron Information Technology Co.
Hewlett-Packard Company
JCPenney
Kraft Foods, Inc.
McCann-Erickson Worldwide
Merrill Lynch
Minnesota Mining & Manufacturing Co.
NCR
Nortel Networks
Royal Ahold
Gray Matters
AARP
Penny PC
Agfa-Gevaert
Becton, Dickinson and Company
DuPont
The Gillette Company
Hewlett-Packard Company
Intracom
International Business Machines
Lucent Technologies
Minnesota Mining & Manufacturing Co.
The Procter & Gamble Company
Roche Diagnostics Corporation
SCA
Time Inc. Production
TOPPAN Printing Co., Ltd.
Toshiba
Toys of Tomorrow (TOT)
Deutsche Telekom AG
Hasbro
International Olympic Committee
Mattel, Inc.
Nickelodeon
Polar Electro Oy
Tomy Company, Ltd.
Warner Bros.

RESEARCH CONTRACTS
Defense Advanced Research Projects Agency
Department of the Army
Deutsche Telekom Berkom GMBH
Hewlett-Packard Company
Honda R&D Co., Ltd.
Microsoft Corporation
National Science Foundation
Nortel Networks
University of California, Berkeley

MEDIA TECHNOLOGY GROUP
ADVO, Inc.
GeoPartners Research, Inc.
Magneti Marelli S.p.A.
Nippon Columbia Co., Ltd.
The Post Office (U.K.)
Shiseido
Storage Technology Corporation

ENDOWMENT AND NAMING GRANTS
Rudge and Nancy Allen
Asahi Broadcasting Corporation
AT&T Corp.
Armand and Celeste Bartos
BT
Alex Dreyfoos, Jr.
Fukutake Publishing
The LEGO Group
LG Electronics, Inc.
MasterCard International
Misawa Homes
Motorola, Inc.
NEC
Isao Okawa
Schlumberger
Sony Corporation
Swatch AG
Telmex
Toshiba
Philippe Villers
Muriel R. Cooper Memorial Professorship
DDP Digital Publishing, Inc.
Origin/Media Lab BV

DEAN, SCHOOL OF ENGINEERING

Through engineering education and research, the School of Engineering develops future technological leaders and advances the frontiers of engineering knowledge. The School develops innovative technologies, theory, and practice and prepares students for leadership in industry, government, and educational institutions, equipping them to creatively address the world's complex problems. At the dawn of this new century, the School aspires to provide a new model for engineering education and practice. Leadership that emanates from a base of technical excellence and innovation will play a critical role in a world increasingly dominated by technological developments. The new engineering leader will combine a solid foundation of engineering fundamentals with an increasing breadth of experience in other areas. By solving problems from a holistic viewpoint that is deeply rooted in technology, these leaders of the future will create, develop, organize, and manage visionary new technologies and products for the betterment of humankind.

Currently, the School's eight departments and two divisions encompass a community of many of the world's brightest minds and inventive thinkers—roughly two-thirds of MIT's undergraduates with declared majors, nearly half of MIT graduate students, and just over one-third of the Institute's faculty. During the 1999–2000 Academic Year, the School undertook several major initiatives that underscore its commitment to maintaining a leadership role in shaping engineering education and research. The following presents selected highlights of significant achievements of the School: major new partnerships with industry; significant capital construction projects; and innovations in education, including new degree programs. In addition, this report includes updates on notable awards, personnel changes and tributes, special programs, and School statistics. The reports of the School's departments, divisions, laboratories, centers, and programs provide additional information about the past year.

PARTNERING WITH INDUSTRY

Industrial research collaborations undertaken by MIT and the School of Engineering have created new knowledge and transferred science and technology into industry, resulting in the creation of jobs, companies, and even new industries based on new technologies. In recent years, MIT has become a leader in developing research and education partnerships with industry, many of them based on significant involvement of the School of Engineering. For the School's graduate and undergraduate students, these industry collaborations also bring significant real-world technology and engineering issues into their studies. This past year, the Institute has initiated several new partnerships.

DuPont

In September 1999, DuPont and MIT announced an agreement to form a $35 million alliance. The goal of this alliance is to advance research and education in materials from biotechnology that have a variety of applications. Begun in January, the five-year alliance supports projects that draw upon expertise from the Schools of Engineering (particularly in materials science, chemical processing, and in the emerging field of bioengineering), Science, and Management and that extend and better leverage the reach of DuPont's scientific expertise in the areas of biology, genetics, bioinformatics and catalysis. With its strategic focus at the interface of biology, materials and engineering, the alliance aims to develop processes for new materials directed at bioelectronics, biosensors, biomimetic materials, alternative energy sources, and new high-value materials.

Microsoft Corporation

In October 1999, Microsoft and MIT announced an alliance to enhance university education through information technology. Named "Project I-Campus," the collaboration involves cooperative projects among members of Microsoft Research and students, faculty, and researchers at MIT, particularly in Engineering. In addition to assigning several research staff members to this effort, Microsoft is allocating $25 million for work at MIT over the project's five-year lifetime. The Co-Directors for the project from MIT are Professor Hal Abelson, the Class of 1922 Professor in the Department of Electrical Engineering and Computer Science and Institute Professor Thomas Magnanti, Dean of Engineering.

Leveraging many of the successful inventions and innovations in computers and telecommunications that have occurred in the last half of the 20th century, the partnership aspires to use modern information technologies to reinvent teaching, learning, and university administration for the 21st century research university. It involves research and development in new pedagogical approaches and structures, integrating information technology concepts and methods throughout university education, and addressing the changing environment of university.

Project I-Campus began with three initial projects in October: an expansion of the MIT Shakespeare Electronic Archive; the design of an educational system using a "global classroom" established last year between MIT and The National University of Singapore under the auspices of the Singapore-MIT Alliance (which also includes Nanyang Technological University); and an initiative in the Department of Aeronautics and Astronautics on the experimental use of distance collaboration in design courses. Both MIT and Microsoft plan to engage additional academic and industry partners as the project evolves and produce materials that can be widely published and disseminated. Through its initial focus on methods and technologies that will enhance education on the MIT campus, Project I-Campus aspires to set the pace for university education in the next five to 10 years.

Nanovation Technologies

In January 2000, Nanovation Technologies and MIT announced plans to establish a world-class center dedicated to the research and prototyping of light-based photonic technologies, a 21st-century development that has the potential to revolutionize communications and boost speeds by hundreds of times. The Miami-based firm is funding a $90 million, six-year program to establish and operate the MIT center and interdisciplinary research program. Nanovation will sponsor research on photonic, microphotonic and nanophotonic devices, circuits and systems, and other photonics-related technologies for telecommunications, data communications and computing applications.

The alliance also serves to strengthen research-based teaching of undergraduates and graduate students. In addition to establishing a state-of-the-art facility where students and faculty can conduct leading-edge research, $10 million of the total Nanovation commitment will support endowed professorships. Professor Lionel C. Kimerling, Director of the School's Materials Processing Center (MPC), will direct the new center. An initiative of the MPC, the Nanovation-sponsored research center brings together faculty and students from several departments within the Schools of Engineering and Science, as well as researchers from Nanovation. Future developments in photonics are expected to expand bandwidth and carry hundreds of times more information via devices that are hundreds to thousands of times smaller than current technology.

Hewlett-Packard Company

In June, the Hewlett-Packard Company (HP) and MIT signed a memorandum of understanding to form a $25 million alliance to develop innovative ways to create and handle digital information. The five-year alliance will investigate new architectures, devices, and user interfaces in information-rich environments, and explore novel services for commerce, education, and personal use. Capitalizing on the long collaboration between the two organizations, in particular between HP and the Department of Electrical Engineering and Computer Science (EECS), the HP/MIT alliance will address and support research and educational programs of mutual interest.

Current plans include projects with the World Wide Web Consortium and Oxygen within the Laboratory for Computer Science, as well as with the Artificial Intelligence Laboratory, the Media Laboratory, the Sloan School Center for eBusiness@MIT, the Internet and Telecoms Convergence Consortium, and the MIT Libraries. Overseen by a joint steering committee, the alliance will define and fund other projects in the future. Institute Professor Thomas Magnanti, Dean of Engineering, will serve as the MIT Co-Director of the alliance.

The School initiated other MIT-industry research collaborations during the year, including a five-year collaboration with Tokyo Electric Power Company (TEPCO) to develop technological and policy options for nuclear power and its fuel cycle in an increasingly competitive energy market.

INFRASTRUCTURE CREATION

Ray and Maria Stata Center—In Progress

An important goal of the Ray and Maria Stata Center for computer, information, and intelligence sciences is to create a community for research and education. The approximately 430,000-square-foot Center will house the Laboratory for Computer Science (LCS), the Artificial Intelligence Laboratory (AI Lab), the Laboratory for Information and Decision Systems (LIDS), and the Department of Linguistics and Philosophy, with some facilities for the Department of Brain and Cognitive Sciences and the Department of Electrical Engineering and Computer Science (EECS), as well as numerous spaces for community use. The Center will also redefine the northeast entrance to MIT's campus, serving as a new interface between Cambridge and MIT. In the past year, architects Frank O. Gehry and Associates completed the Design Development stage of the project. Many key donors and distinguished guests, as well as scores of members of the MIT community, attended a ceremonial ground-breaking held in March. Actual construction work on the site began in April. Major fundraising efforts continue in support of this important project.

Learning Laboratory for Complex Systems—In Progress

As an essential step toward achieving its mission to prepare engineers for success and leadership in the Conception, Design, Implementation, and Operation (CDIO) of aerospace and related complex high-performance systems, over the past year, the Department of Aeronautics and Astronautics has undertaken the construction of a new Learning Laboratory for Complex Systems. This endeavor will create a world-leading teaching laboratory that integrates the teaching labs, prototype shop, integrated product development areas, and hands-on engineering classroom into one interactive, interdisciplinary learning environment. This initiation has required the development and renovation of 40,000 square feet of space, including the revitalization of Building 33 and the Wright Brothers Wind Tunnel, and the construction of high-bay hangar space for student projects. The Department plans to complete this key project by late this summer and will host a "Celebration of Aerospace" in September which will include the dedication of the new Learning Laboratory for Complex Systems.

INNOVATIONS IN EDUCATION

Singapore-MIT Alliance

Established in November 1998, the Singapore-MIT Alliance (SMA) focuses on engineering education and research. A major partnership between the School of Engineering and the Sloan School of Management with the Republic of Singapore's two leading research universities, The National University of Singapore (NUS) and Nanyang Technological University (NTU), the SMA explores the application of information technology to create a new global model for long-distance engineering education and collaborative research.

The SMA makes extensive use of state-of-the-art information and communications technology, including Internet2, to facilitate interactions in teaching and research between MIT faculty and students and faculty in Singapore. In July 1999, the School of Engineering began offering two new graduate-level programs in Singapore: "Advanced Materials" and "High Performance Computation for Engineered Systems." Hosted by NUS, professors from all three universities have conducted these programs. In July 2000, NTU will begin offering a third program in "Manufacturing Systems and Technology." The SMA offers a professional master's-level degree program, as well as master's- and doctoral-level research degree programs, and is expected to grow to five graduate programs after another year.

Cambridge-MIT Institute

In November 1999, the University of Cambridge and MIT signed a memorandum of intent to create the Cambridge-MIT Institute (CMI). The major new education and research partnership builds on the complementary strengths of the two universities and has the financial backing of the UK Treasury for 80 percent of its $135 million (£84 million) budget for the first five years, with the balance of the funding to come from British industry. CMI will develop educational and research programs designed to stimulate the development of new technologies, to encourage entrepreneurship, and to improve productivity and competitiveness. Utilizing faculty and students from Cambridge and MIT (at first, primarily from the Schools of Engineering and Management, and eventually from all five Schools), CMI will concentrate on undergraduate and faculty exchanges, integrated research, professional development for executives, and collaboration with eight British universities designated as Enterprise Centers.

The School's Engineering Systems Division and Cambridge's Manufacturing Institute will jointly offer startup activities that include programs in manufacturing, product development, and industrial competitiveness; experience gained through SMA will provide a framework for MIT educational programs offered at a distance with Cambridge. Professor John VanderSande, the Cecil and Ida Green Distinguished Professor in the Department of Materials Science and Engineering, was named the MIT Co-Director of CMI in February. It is anticipated that CMI could have a significant impact on future technologies and in the evolution of our economy. It could potentially transform both Cambridge and MIT and create a new model for the global research university in the 21st century.

Siebel Scholars

In April, the e-business firm Siebel Systems, Inc. announced gifts of $2.6 million each to the School of Engineering and to the Sloan School of Management, along with an annual $25,000 scholarship to be awarded to a student selected by the Dean of each School. The Siebel Scholars program recognizes outstanding students at prestigious computer science and business schools across the country as part of an educational initiative to produce the next generation of corporate executives by assisting institutions that foster academic excellence and leadership.

Product Development Leadership for the 21st Century

In May, the Navy announced that its Naval Postgraduate School in Monterey, CA will offer a master's of science degree in product development under the distance education program for Product Development Leadership for the 21st Century (PD21). Targeted at full-time professionals working in Navy and Marine Corps organizations responsible for the development and acquisition of major defense systems, the Navy's two-year PD21 curriculum will begin in September and will be conducted entirely through the use of distance education technology at several military installations across the country. The PD21graduate degree program, jointly developed by the Schools of Engineering and Management, aspires to produce a core group of professionals poised to develop and build new systems and products. Responding to a huge demand and with the help of a National Science Foundation grant of $600,000, MIT established a multi-university consortium to replicate the educational program at a number of other universities with the help of several corporations. The initial partner universities are the Rochester Institute of Technology (with Eastman Kodak Company and Xerox as their primary partners) and the University of Detroit Mercy (with Ford Motor Company as its partner and input from General Motors and Chrysler Corporations). The Navy has now become the third partner to offer this graduate degree.

New Degree Programs

Supported by a grant from the Whitaker Foundation, the Division of Bioengineering and Environmental Health (BEH) established a new Ph.D. program in Bioengineering that began in Fall 1999. Offered along with the ongoing Toxicology Ph.D. Program within BEH, the new program aims to educate a new generation of graduates able to solve problems through the use of modern biological technology and emphasizes the ability to measure, model, and manipulate biological systems rationally. Its curriculum strives to teach both biology and engineering as synergistically as possible and focuses on fundamental concepts more than specific applications.

In addition, the MIT Faculty approved a proposal this Spring by BEH to establish both a new S.M. Program in Bioengineering and a new Master's of Engineering (M.Eng.) program in Biomedical Engineering. The S.M. degree, which will be closely related to the BEH doctoral program, will provide a terminal degree for students not continuing for the Ph.D. and will also serve as the initial MIT graduate degree for certain students entering the Ph.D. program in Medical Engineering and Medical Physics [The Harvard-MIT Division of Health Sciences and Technology (HST)]. Similar to other M.Eng. programs in the School, the new Master's in Engineering in Biomedical Engineering (MEBE) will create a 5-year undergraduate program coupled with the S.B. degree in a School of Engineering or School of Science department major. Building on the existing undergraduate minor in biomedical engineering, it is designed for students interested in the biomedical products or biotech industries or a medical degree or for those who want to do further graduate studies in bioengineering or medical engineering.

MIT Faculty also voted in May to establish a new M.Eng. program in the Department of Materials Science and Engineering (DMSE). Designed to be a terminal degree, the new M.Eng. will serve as a post-graduate educational pathway for practicing engineers. It is targeted to three categories of students: students continuing after the undergraduate degree; experienced professionals returning for "retooling;" and experienced professionals who will return to their companies, but with increased job opportunities. The curriculum for the 12-month program will include a new course designed specifically for the M.Eng. program plus existing graduate courses in the basics of the thermodynamics, kinetics and properties of materials. The program is slated to admit students in the Spring of 2001.

AWARDS

Each year faculty of the School of Engineering receive numerous honors in recognition of their research and service, many offered by professional societies and the faculties' professional communities, as well as national recognitions. This year was no exception. The reports of the School's departments, divisions, laboratories, centers, and programs make note of many of these awards. Several especially notable awards deserve additional mention here.

In late January, President Clinton awarded the *National Medal of Science* to Kenneth N. Stevens, the Clarence J. LeBel Professor of Electrical Engineering in the Department of Electrical Engineering and Computer Science (EECS), one of 12 recipients of the 1999 National Medal of Science awards, for his research in speech sciences. In April, President Clinton nominated National Medal of Science winner and Institute Professor Mildred S. Dresselhaus, a professor in the Departments of EECS and Physics, to serve as *Director of the Office of Science at the Department of Energy (DOE).*

This year, the *National Academy of Engineering* (NAE) elected three members of the School of Engineering faculty to membership: Professor of Naval Architecture Justin E. Kerwin, Professor of Aerospace Information Systems Nancy G. Leveson, and Gerald J. Sussman, the Matsushita Professor of Electrical Engineering. The *National Academy of Sciences* (NAS) elected to membership Howard Brenner, the Willard Henry Dow Professor of Chemical Engineering. The *American Association for the Advancement of Science* (AAAS) awarded the distinction of Fellow to two professors of Nuclear Engineering: Michael W. Golay and Lawrence M. Lidsky, and elected Institute Professor and Dean of Engineering Thomas L. Magnanti to membership.

Three MIT faculty members were among the 60 recipients of *the 1999 Presidential Early Career Awards for Scientists and Engineers* (PECASE), the highest honor bestowed by the United States government on young professionals at the outset of their independent research careers: John M. Chapin, Assistant Professor in the Department of EECS; Kenneth R. Czerwinski, the Rasmussen Career Development Assistant Professor in the Department of Nuclear Engineering; and Feniosky Peña-Mora, Co-Director of the Intelligent Engineering Systems Laboratory and the Gilbert W. Winslow Career Development Professor in Civil and Environmental Engineering.

The highest honor the MIT faculty can bestow on one of its colleagues is *Institute Professor.* This year, the faculty gave this honor to Joel Moses, the Dugald C. Jackson Professor of Computer Science and Engineering.

Awards for Contributions to Education, Service

The *Gordon Y Billard Award* recognizes special service of outstanding merit performed for the Institute by a faculty member, nonfaculty employee, or one not necessarily affiliated with MIT. This year, MIT presented one of two such awards to Donna R. Savicki, Assistant Dean for Administration for the School of Engineering.

The *Amar Bose Awards* for Excellence in Teaching recognizes a faculty member whose teaching contributions over an extended period of time are characterized by dedication, care, creativity, and inspiration to students and colleagues. The School presented this award to Professor Gareth McKinley of Mechanical Engineering and gave the *Junior Amar Bose Teaching Award* to Professor Paula Hammond of Chemical Engineering in recognition of her outstanding contribution to undergraduate education.

The *Harold E. Edgerton Faculty Achievement Award* is given each year to an untenured faculty member for exceptional distinction in teaching and in research or scholarship. This year, Associate Professor L. (Maha) Mahadevan, the Karl van Tassel Career Development Associate Professor of Mechanical Engineering, received the Edgerton Award.

In recognition of their devotion to undergraduate education at the Institute, MIT named four School of Engineering professors and two associate professors as 1999–2000 *MacVicar Faculty Fellows*: Professor Rohan Abeyaratne, Associate Head of the Department of Mechanical Engineering; also of Mechanical Engineering, Professor Ernest G. Cravalho, the Taplin Professor of Medical Engineering in the Harvard-MIT Division of Health Sciences and Technology (HST) and Co-Director of the new Program in Biomedical Engineering; Associate Professor Dava J. Newman of Aeronautics and Astronautics, the first junior faculty member to be named a MacVicar Fellow, and Associate Professor Jacquelyn C. Yanch of Nuclear Engineering.

The School presented the *Ruth and Joel Spira Awards* for Teaching Excellence this year to Associate Professor Gareth McKinley of Mechanical Engineering, Assistant Professor Leonard McMillan of EECS, and Associate Professor Jacquelyn C. Yanch of Nuclear Engineering. The Spira awards were established with a gift from Mr. and Mrs. Joel Spira to honor faculty in the three departments listed above, both for teaching excellence and in acknowledgment of the tradition of high quality engineering education at MIT.

Awards Received by Engineering Students

Chee We Ng, a senior in EECS, received the *Henry Ford II Scholar Award,* given to a senior in the School of Engineering who has attained the highest academic record at the end of the third year and who exhibits exceptional potential for leadership in the profession of engineering and in society.

Jennifer T. Law, a junior in EECS, received one of two *Barry Goldwater Scholarships* given to MIT students this year. The award is given to students who exhibit outstanding potential and intend to pursue careers in mathematics,

the natural sciences, or those engineering disciplines that contribute significantly to the technological advances of the United States.

The 1999 *BF Goodrich Collegiate Inventors Program* named Amy Smith, a graduate student in the Technology and Policy Program, as one of three winners. Her Phase-Change Incubator is a clinical apparatus with the ability to maintain a constant temperature without requiring electricity, expected to prove advantageous for lab work in developing countries.

The *Albert G. Hill Prize* is awarded to minority juniors or seniors who have maintained high academic standards and made continued contributions to the improvement of the quality of life for minorities at MIT. Danielle A. Hinton, a senior in EECS, wone the award this year. A former vice president for research, Dr. Hill was an early champion of equal opportunity at MIT.

Amy Smith, noted above, won one of two *Lemelson-MIT Program prizes* for students, winning the sixth annual Student Prize for Inventiveness. Three doctoral students in EECS, Michael Lim, Jalal Khan, and Thomas Murphy, received the Student Team Prize, a new award this year given for innovativeness in telecommunications and networking technologies. The three won the prize for their fabrication and design research in integrated optical devices. The methodology developed by the three could facilitate additional breakthroughs in the high-capacity telecommunications transmission industry.

The *Ronald E. McNair Scholarship Award* recognizes black undergraduates who have demonstrated strong academic performance and who have made considerable contributions to the minority community. Both juniors in Chemical Engineering, this year's recipients were Carla M. Merritt and Stephanie C. Espy. The Black Alumni/ae of MIT created the award in honor of Dr. McNair (Ph.D. 1977), who died in the explosion of the space shuttle Challenger.

The *Reinhold Rudenberg Memorial Prize* for an outstanding undergraduate thesis is awarded to students based on their senior theses in the area of energy conversion. Awards this year went to two seniors from Mechanical Engineering: Fritz Pierre, Jr. and Jason Lawrence and to two seniors from the Laboratory Electromagnetic and Electronic Systems: David Earl Robison and Warit Wichakool.

Four students received *William L. Stewart Jr. Awards*, which recognize contributions by an individual student or student organizations to extracurricular activities and events during the preceding year: Susan Dacy, a graduate student in EECS; Sarah L. McDougal, a senior in Civil and Environmental Engineering; David F. McGill, a senior in EECS; and Sanith Wijesinghe, a graduate student in Aeronautics and Astronautics.

Ticora V. Jones, a senior in Materials Science and Engineering and a group facilitator and tutor for the Office of Minority Education, won the *Tutor of the Year* award. A co-founder of the Black Women's Alliance of MIT, she also received a *Leadership Award* at the 26th annual Dr. Martin Luther King Jr. Celebratory Breakfast.

PERSONNEL

Professor Hal Abelson of EECS, a Class of 1922 Professor and MacVicar Teaching Fellow, became an MIT Co-Director of the MIT-Microsoft alliance, Project I-Campus, in October 1999.

Professor Vincent Chan, who came from MIT's Lincoln Laboratory to join two departments, EECS and Aeronautics and Astronautics in 1998, became Director of the Laboratory for Information and Decision Systems (LIDS) in July, after serving as Co-Director since the previous December.

Dr. Joseph Harrington, left the positions of Assistant Dean and Director of Development for the School of Engineering to take a position as Senior Development Officer in Resource Development as of July 1, 1999.

After serving as chief scientist of the US Air Force for two years, Professor of Aeronautics and Astronautics, Daniel Hastings, returned to MIT and, on February 1, became Co-Director of the Technology and Policy Program (TPP).

Professor Lionel C. Kimerling, Director of the Materials Processing Center (MPC), will direct the new Nanovation-sponsored center in light-based photonic technologies.

Institute Professor Thomas L. Magnanti, Dean of Engineering, became an MIT Co-Director of the MIT-Microsoft alliance, Project I-Campus, in October 1999.

Professor Subra Suresh, the R.P. Simmons Professor of Materials Science and Engineering and a professor of Mechanical Engineering, became the new head of the Department of Materials Science and Engineering beginning January 16. He succeeded Thomas Eagar who served as Director for five years.

Professor John B. VanderSande, the Cecil and Ida Green Distinguished Professor in the Department of Materials Science and Engineering, was named the MIT Co-Director of the newly created Cambridge-MIT Institute in February.

Professor J. Kim Vandiver, founding Director of the Edgerton Center and former Director of the Experimental Study Group, became Dean for Undergraduate Research, a new rendering of the former position of Dean for Undergraduate Curriculum as of July 1, 1999.

Professor Dick K.P. Yue, Professor of hydrodynamic and ocean engineering, Director of the Vortical Flow Research Laboratory, and Associate Director of the MIT Testing Tank Facility, became Associate Dean of the School of Engineering in September 1999.

TRIBUTES

Special tributes to the accomplishments of two of the School of Engineering's faculty deserve special mention: "Policy Studies in Engineering Education: A Tribute to Professor Richard deNeufville" held in May and the Merton C. Flemings Symposium held in late June. Professor Richard de Neufville, professor of engineering systems and civil and environmental engineering, has served as chair of the Technology and Policy Program (TPP), a pioneering interdisciplinary program, for 24 years. For his TPP efforts, Professor de Neufville won MIT's Irwin Sizer Award for the Most Significant Improvement to MIT Education and the MIT Class of 1960 Fellowship. The French government named him a Chevalier de l'Ordre des Palmes Académiques in 1999. Topics of the May 5 event included the role of integrated technology and policy education, the implementation of policy education at MIT, and the importance of a policy capability in the engineering profession.

To celebrate the accomplishments of Professor Merton C. Flemings and to mark his 70th birthday, the Minerals, Metals & Materials Society and the Department of Materials Science and Engineering (DMSE) jointly sponsored a special symposium in late June. Attendees from around the world attended this event "to recognize and acknowledge Merton C. Flemings' contribution to MIT and the materials science and engineering community as an outstanding educator, researcher, technology policy leader, mentor, and friend." For five decades, Professor Flemings' research and teaching has concentrated on engineering fundamentals of materials processing and on innovation of materials processing operations. The Ford Professor of Engineering and the Toyota Professor of Materials Processing, Professor Flemings is the founder of the Materials Processing Center at MIT, former Department Head of DMSE, and the current Director of the Singapore-MIT Alliance.

SPECIAL PROGRAMS

The School of Engineering offers two special programs: the Minority Introduction To Engineering, Entrepreneurship, and Science (MITE^{2}S) and the Engineering Internship Program (EIP).

Minority Introduction To Engineering, Entrepreneurship, and Science

This year, the MITE^{2}S program selected 62 underrepresented minority high school seniors to participate in its rigorous, six-week session. Chosen from nearly 600 applications, the students will come from 26 states, the District of Columbia, and a military base in Germany. The session will include a seminar series begun last year, entitled "Introduction to Engineering,," and will add both career and study skills workshops. A mix of corporations, foundations, alumni of the program, and parents of former participants has made major contributions in support of the 2000 session. The program will host its first reunion during MITE^{2}S 2000 and expects over 170 students, alumni, sponsors, and other guests to attend a two-day silver anniversary celebration. Marking its 25th year, the MITE^{2}S program produced a video documentary to help with fundraising and recruitment. For its 2001 session, MITE^{2}S plans to increase the size of the program to 80 students and to add a new design course in robotics. Of the 60 students who attended MITE^{2}S 1999, a record 55 applied to MIT and 52 (also a record) were accepted. Twenty-eight of the latter will attend MIT this year.

Engineering Internship Program
During the summer of 2000, 31 students will participate in internships through the EIP: six from Aeronautics and Astronautics, two from Materials Science and Engineering, and 23 from Mechanical Engineering. Given an increase in choices among summer internships, summer jobs,and five-year master's programs available to School of Engineering students, the EIP plans to evaluate over the coming year the benefits and cost of maintaining the EIP as currently structured.

STATISTICS FOR 1999–2000

The following presents a summary of statistical information about students, degrees awarded, and faculty.

Undergraduate Enrollment
2,011 students
34% women
20% underrepresented minorities

Graduate Enrollment
2,504 students
22% women
4% underrepresented minorities

Degrees Awarded
715 Bachelor's Degrees
739 Master's and M.Eng. Degrees
237 Ph.D., Sc.D., and professional engineering degrees

Faculty
217 Professors
69 Associate Professors
47 Assistant Professors
52 Professors Emeriti

More information about the School of Engineering can be found on the World Wide Web at http://web.mit.edu/engineering/www/.

Thomas L. Magnanti

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

The academic year 1999–00 was a year of expanding activity for the department. We continued our full-scale implementation of our strategic plan. The plan was a reaffirmation of our focus on the intellectually and industrially robust field of aerospace, coupled with a commitment to redirect the intellectual basis of the Department to set and serve the directions of this industry. The new vision of the department which emerges is one which stands on three broad disciplinary bases: the traditional engine and airframe disciplines; the disciplines of real time system critical aerospace information engineering; and the disciplines required to architect and engineer extremely complex systems.

During AY 99-00, we continued laying the foundation for our extensive reform of undergraduate education, which makes the conception, design, implementation, and operation of complex systems and products the context of engineering education. Major accomplishments this year included extensive experimentation with new teaching and learning technologies, and the completion of our new learning laboratories, The Robert Seamans Laboratory and the Arthur and Linda Gelb Laboratory. We offered a new undergraduate program for the first time: Aerospace Engineering with Information Technology. Student enrollment at both the undergraduate and graduate level was on an upswing, and once again research activities increased markedly.

The department has now begun to move in its strategic direction and is implementing plans for new thrusts in Systems Engineering and Architecture, Information Engineering, the Engineering Context of Education, Research and Educational Program. The next year will focus on continuing to recruit the faculty to implement this new vision, implementing the action plans, and forging relationships with industry necessary to accomplish our goals.

ACADEMIC PROGRAMS

Table 1. Undergraduate Enrollment over the Last Ten Years

	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Sophomore	75	76	61	33	36	36	30	46	40	48	59
Juniors	87	61	62	60	31	37	31	23	33	37	40
Seniors	104	104	73	66	66	38	37	29	24	35	37
Totals	266	241	196	159	133	111	98	98	97	120	136
% of women	25%	23%	27%	28%	32%	31%	29%	26%	30%	33%	30%
% of Underepresented Minorities	18%	20%	14%	12%	23%	19%	16%	18%	22%	15%	12%

A total of 300 applications were received for the graduate program for the Fall 2000 term. Out of this, 115 were admitted and 62 accepted the offer of admission. Enrollment for Fall, 1999 included 123 S.M., 2 EAA, 69 Doctoral, 8 MEng degree candidates for a total of 202. Total minority students: 7 (4 Doctoral., 3 S.M.). Total women students: 37 (11 Doctoral, 24 S.M., 2 MEng.). For the spring, 2000 term we received 16 applications. We admitted 11 and 8 enrolled, including 1 woman. Zero minority applications were received. Enrollment for spring, 2000 included 98 S.M., 79 Doctoral, and 7 MEng for a total of 184. Total women: 32 (13 Doctoral; 19 S.M.). Total minority: 9 (6 S.M.; 3 MEng).

Table 2. Graduate Degrees Awarded

Degrees Awarded	S.M.	EAA	Doctoral.	MEng	Total
Summer (Sept. 99)	12	0	6	1	19
Fall (Feb. 00)	13	2	8	1	24
Spring (June 00)	25	0	6	3	34
Total	50	2	20	5	77

Table 3. Sources of Funding for Graduate Students, Academic Year 1999–2000

FUNDING	
MIT Fellows/Tuition Awards	42
Outside Fellowships Staff Appointments	4
(RAs, Draper Fellows)	156
Teaching Assistants & Fellows	8
Engineering Internship Program	0
Other Types of Support	
(Employer, Foreign, Self)	0
TOTAL	210

Undergraduate Student Awards

The Yngve Raustein Award established in 1993 by the family and friends of the late Mr. Raustein was presented to Ayanna T. Samuels, a sophomore from Kingston, Jamaica—As a student that best exemplified the spirit of Yngve K. Raustein by her scholarship, team work, and community—uilding within and beyond MIT.

The Unified Engineering Award was presented to graduate teaching assistants Torrey O. Radcliffe of Cambridge, MA, and Marcos "Erik" Carreno of Tulsa, OK—For outstanding service and creativity in advancing the educational objectives of Unified Engineering during the academic year 1999–2000.

The Apollo Program Prize awarded to an Aero Astro student who "conducts the best undergraduate research project on the topic of humans in space" was presented to Dana M. Forti, a junior from Tynsboro, MA—For research and outreach on the tactile feedback parabolic flight experiments.

The David J. Shapiro Memorial Award was given to a team of eight students—To design, build, and fly a high speed electric powered model aircraft in the 2000-01 AIAA/Cessna/ONR Student Competition. The awardees are Larry Baskett , a graduate student from Pleasanton, CA; Bernard F. Ahyow, a junior from Irvine, CA; Daniel J. Benhammou, a freshman from Colorado Springs, CO; Allen Chen, a senior from Newtown, PA; Carol C. Cheung, a graduate student from Woodbury, MN; Adam J. Diedrich, a freshman from Petoskey, MI; Jacob Markish, a senior from Chelmsford, MA; and Lawrence O. Pilkington, a junior from Hyannis, NE.

The Thomas B. Sheridan Prize For Creativity In The Improvement Of Human-Machine Integration Or Cooperation was presented to Katherine H. Zimmerman, a senior from Sandy Hook, CT; and Kamla A. Topsey, a senior from Brooklyn, NY—For the development and testing of a naturalistic driver interface for an automoblile GPS guidance system, which demonstrates a significant improvement in human-machine integration.

The Leaders For Manufacturing Prize was awarded to David E. Carpenter, a senior from Tyler, TX—In recognition of his design of the SPHERES structure in the "Conceive, Design, Implement and Operate" (CDIO) Capstone course.

The Pratt And Whitney Award was presented to Brian D. McElwain, a senior from Phoenix, AZ; and Erin F. Noonan, a senior from University City, MO—For their outstanding achievement in the design, construction, execution, and reporting of an undergraduate experimental project to characterize the buckling response of pressurized fuel tanks for micro launch vehicles. The P&W Award was also given to Paul Eremenko, a junior from W. Lafayette, IN—For his outstanding achievement in the design, construction, execution, and reporting of an undergraduate experimental project to characterize the performance of and design the inner-loop control for an unmanned air vehicle.

The James Means Memorial Award for Excellence in Flight Vehicle or Space Systems Engineering was presented to Allen Chen, a senior from Newtown, PA—For his contributions to the "Conceive, Design, Implement and Operate" (CDIO) Capstone course. His exceptionally hard work and dedication to the team and the project was instrumental in making the SPHERES project a success.

The James Means Memorial Award for Excellence in Space Systems Engineering was presented to Sumita Pennathur, a graduate student from Foxborough, MA—For demonstrated initiative, leadership, and accomplishments on the Mission PreMISS project (Precipitation Measuring Instrument for a Space System).

The James Means Memorial Award for Excellence in Flight Vehicle Engineering was presented to senior Jacob Markish —For technical excellence in the design, development and analysis of a high-capacity long-range cargo aircraft.

The Admiral Luis De Florez Award for Original Thinking Or Ingenuity was presented to Christopher Gouldstone, a senior from Herefordshire, U.K.; and Ryan E. Peoples, a senior from Medford, NJ—For conceiving, designing, implementing and operating a novel testing novel testing methodology for fracture testing of composite materials in cryogenic environments.

The Henry Webb Salisbury established by the family and friends of Henry Salisbury was presented to Jacob Markish—outstanding work in the completion of the Aero Astro undergraduate degree program.

FACULTY NOTES

Steve Hall has been promoted to Full Professor, effective July 1, 2000. James Kuchar has been promoted to Associate Professor, effective July 1, 2000.

Paul Lagace has been elected to Fellow of the AIAA.

Nancy Leveson has been elected to the National Academy of Engineering in recognition of her contributions to safety engineering and computer science. Professor Leveson has also received the Newell Award of the Association for Computing Machinery (ACM), for lifetime contributions to computer science, with emphasis on cross-disciplinary or interdisciplinary linkages.

David Miller has been promoted to Associate Professor, effective July 1, 2000. Dava Newman has been granted tenure effective July 1, 2000.

Dava Newman was among the six professors named MacVicar Fellows for 2000 in recognition of their devotion to to undergraduate education at MIT. She is the first junior faculty member to be honored. Known for her teaching 16.00 (Introduction to Aerospace Engineering), Professor Newman has worked extensively with NASA flying three scientific experiments in space. She is developing a distance collaboration multimedia program for the aero/astro and HST curricula. Of her ambition to become "an excellent educator and mentor," Professor Newman said, "My vision for teaching and learning is simply, 'Love, act, discover, and innovate.'"

Jonathan How joined the faculty April 1, 2000, as Boeing Associate Professor of Aeronautics and Astronautics. Professor How received his S.M. and Ph.D. (1993) from MIT in Aeronautics and Astronautics. Professor How was identified from a year long search for a young leader in aerospace control. He works on a broad set of issues meant to enable high performance robust navigation and control of large and hierarchic systems. At Stanford, Professor How revitalized the control sequence taught to first—year graduate students, created a new subject that synthesized classical and modem control techniques, reorganized the control teaching laboratories, and introduced two new subjects in modem control and system identification. He will be a major contributor to the control field, both as a researcher and as an educator.

Eytan Modiano was appointed Charles Stark Draper Assistant Professor of Aeronautics and Astronautics effective August 1, 1999. Professor Modiano received his M.S. and Ph.D. (1992), from the University of Maryland, College Park, in Communications. From 1993–1999 he was a member of the technical staff at the Lincoln Laboratory. Professor Modiano's area of expertise is in non-homogeneous networks of the kind found when space and terrestrial systems are combined. His appointment supports the department's thrust in "information engineering," particularly the focus area in communications, and with Vincent Chan and John Deyst forms the nucleus of our communications and information systems team.

Ann P. Dowling, Professor of Engineering at Cambridge University spent the Fall term as the Jerome Clarke Hunsaker Visiting Professor of Aeronautical Engineering.

Earle Murman received the 1999–2000 Graduate Teaching Award from Sigmma Gamma Tau.

MASSACHUSETTS SPACE GRANT CONSORTIUM

Laurence Young continues actively as Director of the National Space Biomedical Research Institute (NSBRI), the primary agency for NASA-sponsored space biomedical research. In his role as NSBRI investigator, Professor Young directs two research projects. His NSBRI ground-based study of Principal Investigator-in-a-Box (also known as [PI]) tests the effectiveness of [PI] as an expert system designed to assist astronauts in the monitoring and troubleshooting of experiments conducted during space flight. His NASA Ames-sponsored [PI] project flew on the space shuttle twice during 1998: on Neurolab and with John Glenn on STS-95. Prof. Young is also leading a major new research initiative in artificial gravity. Results from these efforts will help define the limitations and benefits of various possible countermeasures to the postural instability and disorientation problems that result upon a return to gravity after long-duration space flight. He is collaborating on other research being prepared for the International Space Station, including the MICRO-G project to provide advanced force and moment sensors, and a virtual reality experiment informed by Neurolab experience (Professors L. Young and D. Newman, Dr. C. Oman). Prof. Young has also worked with NSBRI and HST toward developing a new graduate program in Space Life Sciences.

ACTIVE MATERIALS AND STRUCTURES LABORATORY

The Active Materials and Structures Laboratory (AMSL) conducts both basic and applied research involving synthesis and application of active materials leading to the development of novel actuators and active control of aerospace systems. Research conducted in the lab is highly interdisciplinary in nature involving various disciplines including material science, structural mechanics, structural dynamics, controls, solid-state actuation systems, and micro-electromechanical systems. Research programs in the laboratory range from investigations on fundamental materials microstructure and development of innovative micro-actuators to macro-scale actuation and active control of helicopter rotor blades. Major research efforts in the year 1999–2000 were:

- to develop novel highly compact miniature transducers called Micro-Hydraulic Transducers (MHT) that are capable of outputting energy at very high power density (>1 kW/kg) for actuation and energy generation applications. A second-generation design of the MHT has been completed through detailed simulations and analyses.
- to continue development of active fiber composites technology moving towards low cost, high performance active materials systems suitable for a broad range of applications in structural control. The program builds on past success in developing a robust piezoelectric fiber composite actuation system while moving toward more economical short fiber active systems
- to focus upon using piezoceramic structural actuators to control the vibration of aircraft fuselage and, hence, reduce the interior noise level. Research 1999–2000 focused upon the design and implementation of arrays of co-located sensors and actuators.
- to improve the performance of underwater transducers through more effective use of the nonlinear response of active materials.
- to understand the power flow and work efficiency for a coupled piezoelectric actuator and non-linear structural load. Research has demonstrated possible increases in the output work and work efficiency of the system. In addition, a testing facility to explore the interworkings of mechanical preload, driving frequency, and ambient temperature has been developed and completed over the last year. The completion of this facility enables testing of active material under different controlled loading conditions and should lead to the discovery of interesting correlations between the properties of active materials and their working environment.
- to develop an active twist rotor for wind-tunnel testing. A research program between NASA Langley/Army Research Laboratory and MIT has been esteblished to evaluate active twist rotor effectiveness.
- to complete manufacture of a Mach scaled CH-47D rotor blade which incorporated an X-Frame discrete actuator to power a trailing edge servo-flap. The performance of the system was evaluated for changing operating conditions such as rotor speed and angle of attack.

FLUID DYNAMICS RESEARCH LABORATORY

The Fluid Dynamics Research Laboratory (FDRL) is active in research concerning computational, analytical and experimental issues in fluid dynamics and aerodynamics. Current research projects include: the development of a "distributed flow simulation environment" capability; aerodynamics of subsonic, transonic, and hypersonic vehicles; aeroelasticity; methods for developing low order aerodynamic models for multidisciplinary analysis; computational and experimental approaches to active flow control; the development of tools for aerodynamic analysis and design; distributed visualization; development of distributed fast equation solvers; and development of algorithms for assessing and quantifying numerical uncertainty.

GAS TURBINE LABORATORY

The Gas Turbine Laboratory is an intellectual community of about 80 people, including 8 faculty and over 50 graduate students focussed on the problems of airbreathing propulsion and energy conversion. Highlights for AY 99–00 include the following.

The "micro engines" (shirt button sized gas turbine and rocket engines) is a multidisciplinary collaboration of about 50 faculty, staff, and students from three departments. This project is device oriented with the aim of producing micromachined MEMS (Micro-Electro-Mechanical-Systems) based gas turbine engines for power production and airplane propulsion, micro compressors for analytical instruments, and rocket engines for spacecraft and micro-launch vehicles. Achievements during the past year include demonstration of the first high thrust micro rocket engine and the first tests of a micromotor driven air compressor.

INTERNATIONAL CENTER FOR AIR TRANSPORTATION

The objective of the International Center for Air Transportation is to improve the safety, efficiency and capacity of domestic and international air transportation and its infrastructure, utilizing information technology and systems analysis. The principle thrusts of ICAT over the past several years have been in advanced Air Traffic Management,

understanding airline industry dynamics and in mitigating adverse environmental effects such as noise and aircraft emissions. The activities in this area have ranged from evaluations of future operational concepts for the US National Airspace System; design of decision aids to improve airport departure performance; development of cockpit and controller alerting systems; evaluation of Collaborative Decision Making between ATC and airlines; evaluation of analytical models of ATM systems and conducting fundamental human performance studies of pilot and controller interactions. ICAT has continued to work in the areas of cognitive systems and decision aids for flight critical cockpit systems. This work includes advanced alerting systems, human understanding of advanced flight automation systems, development of critical software systems and other flight safety topics. ICAT is also a key participant in the Global Airline Industry Study supported by the Sloan Foundation.

LEAN AEROSPACE INITIATIVE

The Lean Aerospace Initiative (LAI) is a consortium-guided MIT research program managed under the auspices of the Center for Technology, Policy, and Industrial Development (CTPID) in collaboration with the Department of Aeronautics and Astronautics. Research is conducted by over a dozen faculty members from the Schools of Engineering and Management, graduate students from several MIT courses and Graduate programs, and staff members of CTPID. LAI is an active partnership among 21 aerospace companies, 13 U.S. government agencies, labor representatives, and MIT. It also collaborates internationally with LARP (Lean Aerospace Research Program) at Linköping University and the UK LAI. The initiative was formally launched in 1993 out of practicality and necessity as declining defense procurement budgets collided with military industrial overcapacity prompting a demand for "cheaper, faster, and better" products using a philosophy called lean. It was documented in the U.S. by researchers from MIT's International Motor Vehicle Program and in the book *The Machine That Changed The World.*

Through active collaboration and this focused team research, LAI delivers an evolving and expanded knowledge base. It's one that addresses complex products with relatively low volume production, the entire enterprise including product development and support, and the extended enterprise level including the government customer. Research rich products such as the Lean Enterprise Model (LEM) result, creating a foundation of reference tools for common awareness, language, and understanding of lean principles.

The past year also saw exciting research progress and insights including: an understanding production system design lessons from the automobile industry (Manufacturing Systems); modeling and analyzing cost, schedule, and performance in complex system product development (Product Development); building information systems to integrate the manufacturing supply chain (Supplier Networks); costs and cycle time implications of contractor and government policies during the development phase of major programs (Policy). This research base ultimately shapes outreach, learning, and enduring products for stakeholder use. It also continues to fold into the LEM and policy recommendations.

LAI delivered major policy recommendations to the Department of Defense this past year. Based on research from the "Economic Incentives for Production Programs," the recommendations are:

- for the customer and contractor to create shared goals jointly in an environment of mutual respect, trust, and commitment;
- to develop a Joint Cost Model (JCM) for the system in production as appropriate;
- for the customer and contractor to negotiate the contract that meets mutually defined goals while remaining responsive to future uncertainty;
- to use insight instead of oversight;
- to commit to a successful long-term relationship; and
- to share benefits.

LAI's Management Team consists of Professor Earll Murman, Co-Director, Department of Aeronautics and Astronautics; Professor Tom Allen, Co-Director, Sloan School of Management; and Mr. Fred Stahl, Stakeholder Co-Director.

LEAN SUSTAINMENT INITIATIVE

The Lean Sustainment Initiative's (LSI) mission to enable fundamental transformation of the U.S. aerospace sustainment enterprise into a cost-effective, quality driven, timely, and responsive combat support system.

Highlights of the year include:

- Developed a systems dynamics model of the USAF sustainment enterprise. The model contained an "as is" description of the upstream activities and the downstream activities. Dynamics involving cannibalization, workload, pipeline delay, ALC work flow, SMAG funding, and decision making are included in the model.
- Developed a metric tree for the F-16 aircraft PDM process and repair-on-demand process. Metric tree includes approximately 29 metric candidates, 6 covariant and 4 outcome candidates.
- Completed a survey of MRO companies to discern industry best sustainment practices
- Developed a framework for defining, classifying, and implementing best sustainment practices (BSP).
- Identified over 2000 documented practices from previous and current research for potential implementation into the USF sustainment arena.
- Provided testimony to the U.S. Congress on JSF technology readiness and logistics.

Future plans include completing the development of the vehicle through which government and industry may support LSI research; and expanding the government stakeholder base to include the Navy, Army, and OSD.

MAN VEHICLE LABORATORY

The Man Vehicle Laboratory continues to be at the forefront of research in aerospace physiology, human factors, and cognitive engineering, supported by NASA, the National Space Biomedical Research Institute, and DOT. Faculty include Professor Dava J. Newman (recently promoted to tenured Associate Professor) and Professor Laurence R. Young. The Director is Charles M. Oman, Senior Lecturer and Senior Research Engineer. Sixteen graduate students, two postdocs, and a dozen undergraduates also participate. Two-thirds of MVL's research relates to human spaceflight. Two major experiments are in development for the International Space Station: VOILA, an experiment on human visual orientation and sensory-motor coordination, and MICRO-G, an investigation of astronaut related microgravity disturbances. Dr. Oman is Principal Investigator of VOILA, which is conducted jointly with colleagues from University of California, Santa Barbara, CNES/College de France (Paris) and York University (Toronto). Dr. Andrew M. Liu is Project Scientist. The MIT Center for Space Research is developing the suite of virtual reality ISS flight hardware in support of the VOILA experiment. MICRO-G is led by Professor Newman, and is conducted jointly with the Politecnico di Milano University in Italy. Using a commercial off-the-shelf development platform, the electronics component of the sensors has been reduced significantly in mass and volume.

The laboratory is also deeply involved in ground based and parabolic flight research in support of the development of countermeasures against the deleterious effects of long duration spaceflight, in support of NASA's HEDS initiative. Research is supported both via the conventional NASA NRA process, and by the National Space Biomedical Research Institute, one of the two new NASA research institutes founded three years ago. Dr. Young ha served as the first Director of NSBRI, and has a joint faculty appointment at Baylor College of Medicine, where HSBRI is headquartered. NSBRI has research teams in each of eight disciplines. Dr. Oman leads NSBRI's Neurovestibular team a group of more than twenty investigators from a dozen different institutions. NSBRI has funded a large number of Boston area research projects, including several through the Harvard MIT Program in Health Sciences and Technology, four of them in the MVL, led by Drs. Oman, Newman and Young in the areas of human visual orientation, bone biomechanics, expert systems and artificial gravity. A collaborative project with Prof. Richard Cohen of HST was also completed. Several related curriculum development, education and outreach programs are underway, including a new space biomedical engineering graduate course, under Prof. Newman's leadership. MVL's Marsha Warren is the full time Boston area coordinator of NSBRI research and academic activities. Dr. Heiko Hecht leads our artificial gravity research project. Dr. Alan Natapoff advises on statistical design of experiments. In other NASA related research, an anthropomorphic robot, on loan from NASA, is being modified by Dr. Newman for testing the ISS space suit and improving future space suit designs. Space suit testing of the current NASA EMU began this year with the human-sized anthopmorphic robot in the MVL Results will lead to recommendations for future planetary space suits (i.e., Mars). Dr. Oman's NASA sponsored research on advanced displays and controls for virtual reality systems continues.

In the aeronautical human factors domain, Dr. Oman is continuing his FAA flight and simulator research in collaboration with colleagues at the DOT Volpe Research Center on vertical navigation FMS displays and HUD display formats for transport aircraft. The group is building a fixed base glass cockpit flight simulator, and is involved with the Microsoft sponsored Project I-Campus effort to develop improved flight simulation software for use in aeronautical engineering education. Dr. Oman is also collaborating with Professor Kuchar on an ASL project on information integration and decision aids, sponsored by the Office of Naval Research.

SOFTWARE ENGINEERING RESEARCH LABORATORY

The Software Engineering Research Laboratory (SERL) was established only this year but has gotten off to a running start by attracting 14 graduate students and significant funding from both government agencies and private industry. A visitor from NASDA (the Japanese version of NASA) joined the laboratory during the year. Projects for NASA Langley, the Air Force, NSF, and Draper Lab were completed and new projects have begun with Eurocontrol (the European organization for the safety of air navigation), Raytheon, and NASA Ames. Nine master's theses were completed.

The long-term goal of the laboratory is to provide techniques and tools that integrate system, software, and cognitive engineering and provide a new generation of technology to enhance the management of complexity in specification, analysis, design, implementation, and verification of complex, safety-critical systems. This technology should allow us to stretch the limits of intellectual manageability so that more complexity and functionality can be built into future systems while still allowing acceptable levels of assurance.

Current Research Projects Include:

Model-Based System Engineering

SERL is designing and evaluating modeling, visualization, and analysis methods that can be used by system engineers to specify and evaluate alternative designs. In addition to assisting engineers in design and validation, these techniques may also be useful in assisting pilots and other operators in learning about and understanding the automation with which they must interact. This year we experimented with the model-based system engineering approach using two real systems: an unmanned autonomous helicopter being developed by Draper Lab and the MD-11 vertical flight control software. We learned important lessons about intellectual manageability of such large specifications that will be used to design tools to assist engineers in developing them.

Accident Modeling

Accident models are used to understand past accidents and incidents and to prevent future ones. Most classic models focus on chains of events and conditions, but such models do not handle well many of the most important and often new factors in today's complex systems such as software error, cognitively complex human error, and managerial/organizational flaws. Together with researchers at NASA Ames, we are devising new accident models that are more appropriate for today's complex and heterogeneous systems. The long-term research goal is to use the models to define new hazard analysis and assessment techniques. The models will be validated using NASA projects. In the past year, the basic principles upon which such a new accident model will be based have been established.

Software and System Safety

Our goal is to develop a theoretical foundation for safety and a methodology for building safety-critical systems built upon that foundation. Research this year focused on deriving new backward hazard analysis techniques for state-machine based languages.

Human-Centered Automation

Our automation designs often do not support the new roles humans are playing in high-tech systems where humans and computers must cooperate to control a complex electromechanical system or physical process. The goal of our research is devise a methodology for integrating the design of human-computer interaction into the system and software design process and to create new human-centered software development practices. We are integrating human-computer interface and interaction requirement specification and design into our new system intent specifications and modeling and analyzing human task models to assist in task allocation, minimizing human overload, and assuring adequate human feedback and control to maintain human mental models. This year we designed a new language for specifying user models of the system from which both system design specifications and operator procedures can be derived. We have been experimenting with it in the context of specifying vertical control in a flight management system.

Software Requirements

Most errors in operational software (and most accidents) can be traced to errors in requirements. But most software engineering methods focus on software design and coding and few techniques exist for validating requirements. The translation from system to software requirements is especially difficult and critical. In addition, changes in requirements during development have been found to be a particular problem in terms of schedule, budget, and quality. Our three goals for requirements research are to: (1) devise modeling and analysis methods for blackbox

software requirements that assist in finding errors early and in validating requirements specifications, (2) define new types of specification (and design) coupling and traceability to reduce the impact of requirements changes on software development, and (3) determine how specification language design and analysis tools can be used to improve specification completeness with respect to common omissions and flaws often associated with serious accidents and losses. This year we completed the design of our new experimental blackbox requirement specification language. The language, SpecTRM-RL, is designed to enforce completeness as much as possible and to enhance reviewability for those completeness aspects that cannot be enforced in the language itself. Evaluation of the language and analysis tools is currently underway or planned to begin soon for aircraft flight management, air traffic control, and industrial robot applications. This year we also started a project to define new types of requirements coupling and traceability to reduce the impact of requirement changes on the development of safety-critical, software-intensive systems. The testbed is a NASA robot.

Human-Computer Interaction
While much research is focusing on the design of interfaces between humans and computers, little work has been done in designing software to reduce operator-error potential. Our goal is to determine how to use system and software models and specifications, analysis techniques, and the results of system hazard analysis to design safer human-computer interaction. This topic includes identifying software features with the potential to induce human error and devising analysis methods to analyze software for these "predictable error forms," potential mode confusion, other aspects of situation awareness, task allocation between the human and computer, and determination of what information humans need and when they need it in order to work in a safe and effective partnership with computers. We also want to evaluate the potential for using blackbox formal requirements specifications in the operator training process to instill deeper understanding of the automation design and how to use it effectively. Our research this year has focused on design of a human task modeling language and development of analysis techniques for potentially error-prone automation features using the descent phase of a commercial aircraft as a testbed.

Software Evolution
Software is not static once it is put into use but requires changes throughout its lifetime. Changing or upgrading software, however, is extremely costly, time consuming, and error-prone. The problems are most extreme for critical software that needs to be revalidated each time it is changed. Work has begun to evaluate whether traceability in our new intent specifications will lessen the cost of reanalysis and verification of safety for proposed changes to the software and system design. The testbed again is a NASA robot.
Software Assurance: Software is increasingly being used to handle critical system functions previously controlled by humans or by simple and easily proven hardware. It is extremely difficult, costly, and time-consuming to provide high assurance of software correctness and safety. This year we started research to define test data coverage for blackbox state-machine models in the same way that structural coverage has been defined for code. We plan to devise techniques and tools for generating test data to various requirements coverage levels and for evaluating the requirements coverage achieved in the software testing process.

SPACE SYSTEMS LABORATORY
The Space Systems Laboratory (SSL), founded in 1995, has the mission of developing the technology and systems analysis associated with small spacecraft, precision optical systems, and International Space Station technology research and development. The laboratory encompasses expertise in structural dynamics, control, thermal, autonomy, space power, propulsion, MEMS, software development and systems. A major activity in this laboratory is the development of small spacecraft thruster systems as well as looking at issues associated with the distribution of function among satellites (Distributed Satellite Systems). In addition, technology is being developed for spaceflight validation in support of a new class of space-based telescope, which exploits the physics of interferometry to achieve dramatic breakthroughs in angular resolution. The objective of the Laboratory is to explore innovative concepts for the integration of future space systems and to train a generation of researchers and engineers conversant in this field.

Distributed Satellite Systems
The objective the SSL's research into distributed satellite systems is to understand when and why it makes sense to distribute mission functionality across multiple satellites. To this end, the SSL has developed the GINA systems architecting methodology for conducting quantitative design trades at the mission concept level. In addition, several enabling technologies are being developed to support such mission concepts.

Space Telescope Dynamics And Controls
The SSL has developed the Dynamics, Optics, Controls and Structures (DOCS) software toolset for analyzing and optimizing the coupled behavior of these disciplines for precision systems such as space telescopes. DOCS provides an immersive environment where complex trades between system design, dynamic behavior, optical layout, and control formulation and be easily conducted on these complex systems. DOCS is currently being used to analyze and design NASA's Space Interferometry Mission, Next Generation Space Telescope and Terrestrial Planet Finder Mission.

Spacecraft Autonomy
We are developing a new paradigm for rapidly creating collections of long-lived, robotic explorers that reason quickly, extensively and accurately about their world. These explorers are prototyped rapidly through an approach we call model-based programming.

In May of 1999, working with NASA JPL and NASA Ames, we demonstrated remote agent, a model-based autonomous system that was able to navigate the NASA Deep Space One probe through a wide range of failures.

We are currently developing a new paradigm that hides powerful deductive capabilities under the hood of a modern reactive programming language called Reactive Model-based Programming Language (RMPL), that is able to model uncertain effects, hidden state, time, redundancy and utility of action. We are currently exploring the deployment of RMPL on NASA's Messenger mission to Mercury, currently under development at the John Hopkin's University Applied Physics Laboratory

We are extending the model-based programming paradigm to the creation of cooperative autonomous agents that are able to create and adapt coordinated mission plans on the fly, by reasoning extensively from models of their constituents, collaborators and pursuance. During the past year we developed the Activity Modeling Language (AML), which extends model-based programming to allow for the expression of complex concurrent behaviors, metric time constraints and multiple contingencies. Next we created the Temporal Planning Network (TPN) representation, a compact encoding of AML models that supports efficient planning. Finally, we implemented a centralized planning system, called Kirk, that draws from the techniques of network search, conflict resolution, and hierarchical decomposition to perform rapid multiple-vehicle mission planning. The Kirk system was demonstrated in simulation to perform a coordinated search and rescue mission. In future years Kirk will be extended to perform high speed, de-centralized planning and coordination.

We are developing a new generation of hybrid health management and control capabilities that unify symbolic, model-based reasoning methods with methods for model-based state estimation and control. During the past year we began the development of methods for learning the parameters of hybrid models that merge discrete automata with ordinary differential equations. These methods are being developed to control and monitor the health of Bioplex, a testbed at NASA Johnson Space Center that simulates a Martian colony.

CENTER FOR SPORTS INNOVATION
The Center for Sports Innovation (CSI) was launched in the fall of 1999. Focused on the development of new technology and products to enhance all aspects of the sporting experience, CSI draws on the vast expertise of MIT faculty and staff, coupled with the passion of students and corporate sponsors, providing a dynamic environment for engineering and product development education, with a clear focus on end use applications. Nearly 20 undergraduate students were involved in CSI programs in the first year. The main focus of the first semester was CSI itself. With guidance from ILP member Hill-Holliday, CSI staff and students focused on the development of a marketing strategy for the center. During the second semester, several programs were launched. This included "Pick-a-Sport" where a student selects a sport of interest, researches the business aspects and marketplace of the sport, maps technologies to the sport, and then identifies areas ripe for innovation. Perhaps the most controversial project is "Strike-Zone." Students are developing a strike zone detection system for use in baseball. In this particular project, the technology is not the hurdle, but rather the acceptance of the product into the marketplace. Thus, much of the work has focused on understanding the sport of baseball from a business perspective, from youth league right on up to the majors. CSI was also actively involved in providing educational experiences to the MIT community at large. During IAP 2000, CSI hosted a sports product development seminar series featuring speakers from Burton Snowboards, Reebok, Tune Corporation, Fitsense, and ACX. CSI also hosted demonstrations for some of the Freshman Advising Program meetings that related to sports. In addition, CSI is currently sponsoring two projects in the 16.621-16.622 course sequence. CSI activities have resulted in wide exposure in the popular press, including 4

MIT publications, broadcasts on local news programs, internationally distributed television programs and national magazines. The media exposure will be quite helpful as we look to expand sponsorship in the coming year.

TECHNOLOGY LABORATORY FOR ADVANCED COMPOSITES

Nearly 40 students were involved in TELAC during AY 1999–2000 including 16 graduate students, 14 UROPers, and 9 students in 16.621/2 who performed their research projects in the laboratory. Six students finished their master's theses in the laboratory during this period and one engineer's degree was completed. The laboratory issued a total of 19 reports during the past year including a number accepted for publication in journals and conference proceedings. Laboratory personnel participated in conferences at the national and international level giving a total of 15 presentations. Important progress was made in a number of research areas throughout the year. These include the development of an integrated model for durability of titanium-graphite hybrid composite laminates; development and demonstration of high-g-survivable structures for gun-launched microaerial vehicles; demonstration of the use of piezo-actuation as an analogue for thermal cycling to perform accelerated testing; extension of models for the damage tolerance response of pressurized composite cylinders to general anisotropic layups; validation of analytical methods for the calculation of interlaminar stresses in arbitrary laminates at ply-drop configurations; demonstration of a prototype active transonic composite compressor blade via bench and spin rig tests; development of a numerical framework to study the effects of distributed anisotropic actuators to improve the aeroelastic response of highly-flexible composite wings; investigation of the effects of large displacements of high aspect-ratio wings on low-order unsteady aerodynamic modeling; further development of a multibody dynamics modeling of a folding wing concept. The laboratory is also participating in the I-Campus/Microsoft initiative via a research project established to build hardware/software and address the educational issues associated with a mechanical experiment to be run remotely from the web. Research partnerships and collaborations continue around many of the laboratory projects and contributed to the efforts and accomplishments previously mentioned. Partners and collaborators include Boeing Aircraft Company, Rockwell International, Sikorsky Aircraft, and Draper Laboratories. Additional sponsors include DARPA, NSF, and NASA. Once again, a significant event during the year was the "Student Symposium on Composite Materials" held for the fifth time this year with continued participation by and between the students working on composites at Virginia Tech and those in TELAC at M.I.T. This year the event was held at Virginia Tech in June with Prof. Mark Spearing spearheading the TELAC coordination. The University of Massachusetts at Lowell and the University of Maryland joined as permanent participants in this important exchange. Both heads of those programs are M.I.T. graduates. Professor Julie Chen from UMass at Lowell is a graduate of the Laboratory for Manufacturing and Productivity and Professor Tim Gutowski; Professor Tony Vizzini from UMaryland is a graduate of TELAC and Professor Paul Lagace.

WRIGHT BROTHERS WIND TUNNEL

The 1999–2000 academic-year saw a sharp increase in the academic utilization of the Wright Brothers Wind Tunnel (WBWT). Professors Murmann and Darmofal, together with support from Lockheed-Martin, used wind tunnel testing of an F-16 model as the cornerstone of their 16.100 aerodynamics course. Student groups spend nearly 20 hours of test time at WBWT in the course of the semester. 16.110, the follow-on course saw Professor Drela utilizing WBWT for instructional purposes as well. And, as is normally the case, 16.621-16.622 projects often utilize WBWT for testing. The current interest in miniature tactical and reconnaissance aircraft has brought new commercial work to WBWT as well. Draper Labs was a repeat customer with several tunnel entries for one of their projects. Additionally, perennial customers, Second Wind, utilized WBWT for anemometer calibration. The new Center for Sports Innovation (CSI) was also a frequent guest at WBWT. The highlight of the year was testing riding position on a prototype time-trial bike for Trek Bicycle Corporation. The final version of this bicycle was used by Lance Armstrong and Tyler Hamilton during Armstrong's win at the 2000 Tour de France. WBWT kicked off 2000 by having students develop data acquisition software using state-of-the-art Windows NT computers and LabView Software. This is a much-needed replacement for the aging PDP data acquisition system.

Edward Crawley

DEPARTMENT OF CHEMICAL ENGINEERING

In the academic year 1999–2000 the department maintained its high productivity and visibility. We continued as number one amongst chemical engineering departments in the annual *U.S. New and World Report* academic survey. We graduated 46 doctoral candidates together with 38 M.S. students, totaling 84 advanced degrees. The research dollar volume of over $17 million was reached to support departmental research activities.

The department's undergraduate enrollment stands at 259 students with approximately 90 students per graduating class and an equal balance of men and women. Pre-registration for the next year indicates that the incoming class size will be approximately 75.

The graduate student enrollment is stable at 199 students with 145 in the doctoral program and 54 master's students, most of whom are in the David H. Koch School of Chemical Engineering Practice. The class includes 58 foreign, 56 women and 12 minority students. This year we received 401 applications for our graduate program, offered admission to 84 students and had 51 accept our offer. The yield of 61% is the highest of any chemical engineering department in the country.

The department, in collaboration with the Sloan School of Management, initiated a new PhD degree program in Chemical Engineering Practice. This program accepted its first five students interested in this unique curriculum which includes a year of core and elective subjects in chemical engineering, a term in the Chemical Engineering Practice School, a research program leading to preparation of a doctoral thesis and the first year of a Sloan MBA program. Students completing the program will have the option of continuing for an additional year to complete the MBA degree.

Professor K. Dane Wittrup from the University of Illinois joined the department with a two-key appointment to the Division of Bioengineering and Environmental Health. Professor Kenneth Beers, from the University of Wisconsin-Madison, joined the department as Assistant Professor in July 2000 and will initiate his teaching and research program this fall. The department hired Dr. Patrick Doyle from Stanford University. Dr. Doyle is finishing a post-doctoral position and will join us for the 2000–01 academic year as Assistant Professor.

Professor Karen Gleason was promoted to full Professor. She is the first woman to hold this rank in the department. Professor Paula Hammond was promoted to Associate Professor without Tenure beginning July 2000.

Several external alliances emerged as important aspects of departmental programs. Professor Jackie Y. Ying will serve as the chair of the Singapore-MIT Alliance Program on Molecular Engineering of Biological and Chemical Systems. Professors Lauffenburger and Cohen co-direct the new DuPont-MIT Alliance on Bio-Based Materials.

We are again proud of the faculty achievements this year and wish to especially note the following awards. Professor Clark Colton received the Food, Pharmaceutical and Bioengineering Award from the AIChE, Professor Paula Hammond received the Junior Bose Faculty Award for Excellence in Teaching, Professor Howard Brenner was elected to membership in the National Academy of Sciences and received the Warren K. Lewis Award of the American Institute of Chemical Engineering. Professor Robert E. Cohen was named as this year's recipient of the Charles M.A. Stine Award by the American Institute of Chemical Engineers, Professor Klavs F. Jensen received the 2000 R.H. Wilhelm Award from the American Institute of Chemical Engineers, and Professor Jackie Y. Ying is the recipient of the 2000 American Institute of Chemical Engineers (AIChE) Allan P. Colburn Award for excellence in publications.

UNDERGRADUATE EDUCATION

Table 1: Undergraduate Enrollment over the Last Eight Years

	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Sophomores	95	115	108	118	87	97	88	71
Juniors	89	90	104	101	121	90	90	85
Seniors	81	84	100	103	110	130	94	103
Total	265	289	312	322	318	317	272	259

The undergraduate program remains strong with excellent students. The computing cluster with 32 PCs for use in undergraduate teaching has become an important gathering point for our undergraduates and we have continued to

expand the portfolio of software for use in association with our subjects. This cluster, in addition to the Athena network, provides our students excellent accessibility to the full range of contemporary computing power. UROP activity remains high, with about one-third of our students participating each term. Much of this activity is in the biomedical and biochemical areas.

A continuing trend is the broadening of the industrial base into which our students enter employment upon graduation. A minority now go into the traditional chemical and petroleum industry, with wide involvement in such industries as biotechnology, semiconductor fabrication, personal care products, consulting (technical, environmental and business), and the financial industries.

GRADUATE EDUCATION

Table 2: Enrollment by Graduate Degrees over the Last Eight Years

	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00
Masters	159	62	64	56	64	51	59	54
Doctoral	164	147	166	169	162	167	140	145
Total	210	209	230	225	226	218	199	199

The total for 1999–2000 includes 58 foreign students, 56 female students, and 12 minority students (not including Asian Americans). Graduate admissions data suggest that graduate enrollment will climb into the low 200s and remain there for the foreseeable future.

In the Spring of 1999, the MIT faculty approved the launch of a new experiment in graduate education involving a partnership between the Department of Chemical Engineering and the Sloan School of Management. The PhDCEP program combines extensive classroom study in the core graduate curricula of both ChemE and Sloan, a term at the stations of the School of Chemical Engineering Practice, an original thesis research project and several integrative projects and seminars. The first group of five PhDCEP students was recruited jointly by a team comprised of members of the Sloan and ChemE graduate admissions committees. These students will matriculate in September, 2000.

Thirty students participated in the David H. Koch School of Chemical Engineering Practice program during the 1999–2000 sessions. GE Plastics continues to host a year-round station, while Cargill will run during spring semesters only, although they also hosted a summer station in June 2000. Last summer we opened a summer station for seven students at Alkermes, Cambridge, MA, while ten students also attended the third summer of operations at the Mitsubishi Chemical Corporation in Mizushima, Japan. Five students from Tokyo University joined the MIT group in August to experiment with a joint program between the two universities. During the fall, students were hosted by Rhone Poulenc in Decines, France. We operated a station at Cabot Corporation, Billerica, MA, during January, 2000, and returned to GE Plastics and Cargill in the Spring of 2000. Dr. Paul Bryan continued as station director for the GE Plastics station. Dr. John Friedly directed the Cargill, Alkermes Cabot and Rhone Poulenc stations. Dr. Barry Johnston directed the Station in Japan, assisted by Alejandro Cano-Ruiz as Assistant Director in summer of 1999, and by Ms. Sonja Sharpe this summer. Professor Alan Hatton continues to direct the Practice School from Cambridge. Carol Phillips, the Practice School Administrative Secretary, retired due to health reasons at the end of June, and will be succeeded by Ms. Arline Benford.

FACULTY NOTES

Professor Robert Armstrong continued as Head of the Department of Chemical Engineering during the academic year 1999–2000. He gave an invited presentation on "Chemical Engineering: the Central Engineering Discipline" to the department Heads Forum of the Council for Chemical Research. He served as Program Chair for the Annual Meeting of the Society of Rheology. He also served on the Visiting Committee for the Department of Chemical Engineering at North Carolina State University.

Professor Paul I. Barton spent two months as Visiting Professor at ENSIC and CNRS, Nancy, France. He gave invited papers at the NSF Workshop on Hybrid Technologies for Waste Minimization, Breckenridge, Colorado; the II Pan American Workshop on Catalysis and Process Systems Engineering, Santa Fe, Argentina; and the Sixth Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado. He gave invited lectures at the University of Rhode Island; ENSIC Nancy, France; Bayer AG, Leverkusen, Germany; and for the Boston chapter of the AIChE. He continued to serve as the AIChE's Group 10C Programming Coordinator. He served on the international programming committee for ADCHEM 2000 and the organizing committee of Process Systems

Engineering 2000. His group released version 1.0 of the DAEPACK software for the automated symbolic, structural and numerical analysis of models coded in programming languages such as FORTRAN.

Professor Daniel Blankschtein was an invited speaker at the International Cosmetic Exposition 2000 in Miami, and a keynote speaker at the 10th International Conference on "Colloid and Interface Science" in Bristol, UK. He was also a member of the International Advisory Committee for the 13th International Symposium on "Surfactants in Solution" held at the University of Florida, and continues to serve on the Editorial Boards of Current Opinion in Colloid and Interface Science and Marcel Dekker's Surfactant Science Series. Professor Blankschtein received the Controlled Release Society-Dow Corning Award for the Outstanding Research Paper at the 26th International Symposium on "Controlled Release of Bioactive Materials" held in Boston. He also received the Outstanding Faculty Award from the graduate students in the Department of Chemical Engineering.

Professor Howard Brenner was elected to membership in the National Academy of Sciences. He also received the Warren K. Lewis Award of the American Institute of Chemical Engineering. He served as a member of the Visiting Committee of the Chemical Engineering department at Texas Tech University, as well as on the Chemical Engineering Peer Review Committee of the National Academy of Engineering. During the year he presented invited seminars at the National Institute of Standards and Technology (NIST), the Technion, Boston University and Northwestern University, in addition to giving papers at meetings of the Society of Rheology, the American Institute of Chemical Engineers, the American Chemical Society and the American Physical Society.

Professor Robert A. Brown continued serving as Provost at MIT. He was the Kelly Lecturer at Purdue University in the spring of 2000. He also continued as Executive Editor of the *Journal of Chemical Engineering Science* and as co-chair, with Professor Ronald Breslow of Columbia University, of the National Research Council decadal study on the Frontiers in Chemistry and Chemical Engineering. Among other forms of service, Professor Brown continued to serve on the International Academic Advisory Panel (IAAP) to the Government of Singapore.

Professor Robert E. Cohen was named this year's recipient of the Charles M. A. Stine Award by the American Institute of Chemical Engineers. The award, which recognizes outstanding achievement in research and education in the field of materials engineering, will be presented in November at a banquet in his honor at the Annual Meeting of the AIChE. In the past year Cohen presented invited lectures at the University of Indiana, Tufts University and the University of Rochester; and he delivered a plenary lecture at the Annual Technical Conference of the Society of Plastics Engineers. In June, Cohen and his research group hosted the 8th annual MIT/Princeton Microsymposium on Polymers. In his role as Graduate Officer in the department, he worked with admissions committees from ChemE and the Sloan School of Management to recruit the first group of five graduate students who will matriculate in September in the department's new PhDCEP program. In January, Cohen assumed administrative responsibilities to co-direct, with Professor Douglas Lauffenburger, MIT's activities in the DuPont-MIT Alliance, a $35 million/5 year cooperative venture to develop research and educational programs at the interface between modern biology and functional materials. Outside the Institute, he was Scientific Advisor and Board Member at the William and Mary Greve Foundation in New York City; a member of the Board of Directors of MatTek Corporation, Ashland, Massachusetts; and Associate Editor of the *Journal of Polymer Engineering.*

Professor Clark K. Colton received the Food, Pharmaceutical, and Bioengineering Award of the American Institute of Chemical Engineers. He presented a keynote lecture at the 74th American Chemical Society Colloid and Surface Science Symposium and a Plenary Lecture at the Annual Meeting of the American Society for Artificial Internal Organs. He gave invited lectures at the WTEC Workshop on Tissue Engineering in the United States and in the Biotechnology Seminar Series of the Tufts University Science and Technology Center. He served as Chairman of the External Review Committee for the Division of Engineering in the Physical and Mathematical Sciences Cluster Review for Brown University.

Professor Charles L. Cooney continues to serve as the Executive Officer of the department. He is on the Board of the MIT Community Services Fund. He is the Co-director of the Consortium for Advanced Manufacturing of Pharmaceuticals (CAMP), an industry consortium jointly run with Purdue University to support research on pharmaceutical manufacturing and continues as Co-Director of the Program on the Pharmaceutical Industry (POPI) a joint program between the Schools of Engineering, Science and Management. During 1999, he co-chaired the 9th conference on Recovery of Biological Products and participated on the Defense Science Board Task Force on Globalization and Security. He is also on the external review committee for the Department of Chemical Engineering of University of Cambridge and is co-chairing an assessment team for technopreneurship programs in Singapore.

Professor William M. Deen was an invited speaker at a symposium on membrane science at the AIChE Annual Meeting in Dallas, TX, on November 2, 1999. He was an invited speaker also at a symposium on kidney microcirculation at the meeting of the European Society for Microcirculation in Stockholm, Sweden, on June 5, 2000. His laboratory continued its investigations in the areas of hindered transport in fibrous media, water and macromolecule filtration in kidney capillaries, and physico-chemical aspects of nitric oxide toxicity and carcinogenicity.

Professor Karen K. Gleason was promoted to the rank of full Professor and also received the 1999 SRC/SSA SEMATECH Excellence Award for Research in Manufacturing and Environment jointly with collaborator Professor Christopher K. Ober of Cornell University. Professor Gleason was an invited lecturer at Harvard, Cornell, SUNY Albany, DARPA, Shipley, and Lucent Laboratory. She gave other invited presentations at the Gordon Research Conference on Electronic Materials (New Hampshire), the Fluorocarbon Plasma Workshop (France), Polymers for Microelectronics (Delaware), VMIC (California), ACS National Meetings (New Orleans and San Francisco), the Workshop of Low-Dielectric Constant Materials (California), and Semicon West (California). Professor Gleason also serves on the Visiting Committee for the Chemical Engineering department at the Colorado School of Mines.

Professor William H. Green was an invited lecturer at the University of California, Sandia National Laboratory, the American Chemical Society's National Meeting, and the AIChE National Meeting. He also gave invited presentations at several other conferences, and at several industrial labs (e.g. ABB Alstom Power, Ford Motor Co., and General Motors). He chaired the session on "Reaction Engineering & Catalysis for Advanced Vehicle Fuels" at the 1999 AIChE National Meeting, and will chair a session on "Combustion Reaction Engineering" at the 2000 AIChE National Meeting. He continues to collaborate with several members of the MIT faculty on various research projects, including a project with R.W. Field from the Department of Chemistry, which was seeded through an Edgerly Science Partnership award.

Professor Linda Griffith continues to serve as PI on a DARPA project to develop tissue-based sensors for biological warfare agents, collaborating with R. Kamm, P. Laibinis, D. Schauer, J. Sherley, P. So, and S. Tannenbaum at MIT, G. Daley at WI, J. Vacanti & R. Lee at HMS, and J. Wands at Brown U. She also continues to work in the area of new polymers for tissue engineering and cell biology. She chaired an NIH workshop on Tissue Genesis and Organogensis for the National Heart, Lung, and Blood Institute, and was elected to serve on the Surgery and Bioengineering Study section. She gave several invited talks at conferences, other universities, and government panels. At MIT, she continues to serve as the Associate Director of Education for BPEC and as head of the Biotech Student Leadership Council.

Professor Paula T. Hammond recently received the Junior Bose Faculty Award for Excellence in Teaching, which was presented by the Dean of Engineering and Professor Amar Bose. She was also the recipient of the GenCorp Foundation Signature University Award for "outstanding research in polymer science and technology" and the Lloyd Ferguson Young Scientist Award. Dr. Hammond was an invited lecturer at several international and national meetings, companies, and universities, including Princeton, Cornell and Columbia Universities. She was also invited to speak at the 2000 Gordon Conference on Polymers Physics as well as the Polymers East 2000 Gordon Conference. Dr. Hammond chaired the 1999 Materials Research Society Symposium on Nonlithographic Approaches to Organized Structures in December, 1999. Prof. Hammond was promoted to Associate Professor without Tenure effective July 1, 2000.

Professor T. Alan Hatton continued to serve as Director of the School of Chemical Engineering Practice at MIT. Invited talks were given at the CEA Saclay, France; Max Planck Society, Golm, Germany; Nestle Research, Lausanne, Switzerland; Warner Lambert, NJ.; and the Universities of Rhode Island and Florida, in addition to many other presentations at national and international meetings. He was on the Organizing committee for Surfactants in Solution 2000 conference in Gainesville, FL. Professor Hatton played a significant role in establishing the "Molecular Engineering of Biological and Chemical Systems" program under the Singapore-MIT Alliance. He serves on the editorial boards of a number of scientific journals.

Professor Jack B. Howard continues to serve as Director of the Center on Airborne Organics involving MIT, California Institute of Technology and New Jersey Institute of Technology. He continues to do collaborative research with J.B. Vander Sande (MSE) on fullerenic carbon materials. He gave invited lectures at University of Michigan and New Jersey Institute of Technology on ultrafine atmospheric particles from combustion sources, and at University of Arizona and Technical University of Darmstadt in Germany on combustion synthesis of fullerenes.

Professor Klavs F. Jensen received the 2000 R.H. Wilhelm Award for reaction engineering from the American Institute of Chemical Engineers. He presented the 2000 Berkeley Lectures at the University of California, Berkeley. Professor Jensen continued research on multiscale modeling of reactive processes for thin film deposition, microfabricated chemical systems for synthesis and analysis [in collaboration with Martin A. Schmidt (EECS)], novel quantum dot composite materials for optical devices [in collaboration research with M.G. Bawendi (Chemistry)]. He gave several invited presentations on multiscale modeling of thin film deposition and on microchemical systems at the national and international conferences Foundations of Computer Aided Process Design, the Materials Research Society, the Royal Society of Chemistry, the American Institute of Chemical Engineers and at universities, including ETH-Zurich, Technical University Eindhoven - The Netherlands, U. Arizona, and Stanford.

Professor Paul E. Laibinis was promoted to Associate Professor without Tenure, effective July 1, 1999. He delivered the PPG Lecture on Interfaces and Polymers at Harvard University and was an invited speaker at the Gordon Conference on Organic Thin Films, an NSF Workshop on Materials Chemistry, the Volkswagen Foundation Advanced Materials Search Conference, and the 2nd International Symposium on Contact Angle, Wettability, and Adhesion. He gave invited seminars at Vanderbilt University, Syracuse University, the Max-Planck Institute for Polymer Research, the Max-Planck-Institute of Colloids and Interfaces, and at various industrial laboratories. He was selected as a Young Observer to represent the US at the General Assembly of the International Union of Pure and Applied Chemists in Berlin.

Professor Robert Langer received a number of awards in 1999, including the American Chemical Society's Award in Polymer Chemistry, the American Chemical Society's Northeast Section Esselen Award, and the American Pharmaceutical Association's Ebert Prize. Dr. Langer has also been honored as the Beckman Lecturer at the University of Illinois at Urbana, the Reilly Lecturer at the University of Notre Dame, and as the G.N. Lewis Medal winner and Lecturer at the University of California at Berkeley. He gave the Opening Plenary Lecture at the Ninth International Symposium on Recent Advances in Drug Delivery Systems in Salt Lake City, Utah; the Plenary Lecture at the Tutzing-Symposium in Bavaria, Germany; the Opening Plenary Lecture at the 1999 AIMBE Annual Meeting; the Plenary Lecture at the 26th International Symposium on Controlled Release of Bioactive Materials, CRS, in Boston, MA; the Keynote Lecture at the Tissue Engineering Conference for International Business Communications in Boston, MA; the Plenary Lecture at the American Society for Mass Spectrometry in Dallas, TX; and the Keynote Lecture at the Biomaterials of the Future Conference and Exhibition in San Francisco, CA.

Professor Douglas *A.* Lauffenburger was honored during this past year by the Engineering Foundation with the Amgen Award in Biochemical Engineering and by the California Institute of Technology with the Lacey Lectureship in Chemical Engineering; and was elected as Chair-Elect of the College of Fellows of the American Institute of Medical & Biological Engineering. He was also appointed to serve on the Advisory Committee of the Burroughs-Wellcome Program on Interfaces Between the Physical, Chemical, and Computational Sciences. Along with his ongoing duties as Co-Director of the Division of Bioengineering and Environmental Health and the Director of the Biotechnology Process Engineering Center, he was appointed Associate Director of the MIT-DuPont Alliance in Bio-Based Materials.

Professor Gregory McRae, has served on two National Research Council (NRC) panels, one for the National Academy of Sciences on the role of mathematics in physical sciences and another to review the North American Research Strategy for Tropospheric Ozone (NARSTO). In addition, he has been appointed by secretary William Richardson to advise the Department of Energy (DoE) on computational science and engineering. He has given numerous keynote talks on his research on product and process design strategies to improve commercial and environmental performance of chemical plants. A project he initiated last year with Professor Mario Molina of EAPS to understand the formation and transport of air pollution in major cities like Mexico City has now grown to a collaborative team of more than 60 researchers from MIT, Harvard, Mexican universities and industry. Professor McRae is continuing to serve as a member of the Executive Committee of the Partnership for Advanced Computational Infrastructure (PACI). The goal of the 5 year project is to create a high performance distributed computing system across the United States.

Professor Gregory C. Rutledge was a Visiting Professor of Polymer Physics at the University of Leeds, UK, in Fall, 1999. He presented invited lectures at the 2nd Monte Verita Symposium on Modeling of Materials (Ascona, CH); the American Chemical Society Symposium in honor of Andrew Keller; the Engineering Foundation Conference on Processing of Fibers and Composites (Castelvecchio, IT); the Institut Charles Sadron of the CNRS (Strassbourg, FR); and the Department of Materials at the University of Oxford, UK. In Fall 2000, he will hold the H.A. Morton

Distinguished Visiting Professorship in Polymer Science at the University of Akron. He was recipient of the OMNOVA Solutions Signature University Award. He continues to serve as chairman of the Chemical Engineering Department Graduate Admissions Committee and on the editorial boards of *Polymer* and of *Computational and Theoretical Polymer Science.*

Professor Herbert Sawin continues to study the kinetics of the processes used in microelectronics fabrication and also to model the plasma reactors these fabrications employ. He delivered an invited lecture at the Dry Process Symposium in Tokyo on a novel dry cleaning technique for wafer processing that reduces the use of toxic chemicals. At the New England meeting of the American Vacuum Society, he presented an invited paper on the surface kinetics of plasma etching processes which are used to pattern the submicron dimensions on wafers. He was also invited to present short courses on plasma processing at Kodak Corporation and Axcelis Technologies Inc. One U.S. patent on a metal removal process for microelectronics wafer cleaning has been issued to him this year and for two others, U.S. applications were made: a method for the growth of teflon-like films using thermal CVD, and a method for all-dry wafer cleaning and oxide etching,

Professor Kenneth A. Smith has continued his research on the roles of fluid mechanics and transport phenomena in a number of contexts. These include use of the supercritical water oxidation process for destruction of organic wastes (jointly with Prof. J. W. Tester) and the dynamics of micellar self-assembly (jointly with Prof. T. A. Hatton). He is also engaged in the development of an instrument which can determine the size-segregated chemical composition of an aerosol and do so in real time. Elsewhere, Professor Smith served within the National Academy of Engineering as chairman of the membership search committee for the Chemical Engineering Section.

Professor George Stephanopoulos was the *Distinguished Lecturer in Chemical Engineering Research* at Carnegie Mellon University (April 2000) and he presented a seminar in the Chemical Engineering Department of the University of Texas, Austin (May 2000). He was also invited to be the *2000 Roger Sargent Lecturer* at Imperial College, London. In June 2000 he was appointed to the position of the Chief Technology Officer for the group of companies of the Mitsubishi Chemical Corporation, taking a leave of absence from MIT. In January 2000 he chaired the Technical Advisory Board that Mitsubishi Chemical Corporation convened to evaluate the Mitsubishi Kasei Life Sciences Institute. In 1999 he and Professor Gregory Stephanopoulos established the *"Laboratory for Metabolic Engineering and Bioinformatics"* and initiated a number of industrial collaborations in this important area. In the Spring semester he and Professor Gregory Stephanopoulos introduced the new course *"Bioinformatics: Principles, Methods, and Applications"* that drew students from Chemical Engineering, Biology, Chemistry, the HST Program, and the Harvard Medical School. A short course with the same title was taught for the first time in June 2000 and drew a large number of academics and industrial researchers from around the country and overseas.

Professor Gregory Stephanopoulos initiated a new program in Bioinformatics and Metabolic Engineering that aims at the integration of new genomic technologies to the rational analysis and modification of metabolic pathways for the production of chemicals and pharmaceuticals. This program comprises a research component as well as courses on Metabolic Engineering and a new course on Bioinformatics. Professor Stephanopoulos continued as co-editor of the journal *Metabolic Engineering* that he launched last year published by Academic Press. He delivered plenary lectures at the 11th Conference of Biochemical Engineering (Salt Lake City, 99), the 7th Cell Culture Engineering conference, the 9th European Conference on Biotechnology, the Annual SIM Conference, and the British Research Council on the application of genomics to biotechnology. On sabbatical during the spring semester of 2000, he visited and gave lectures at the Catholic University of Chile, the University of Chile, the University of Florida, the University of Utah, Penn State University, University of Massachusetts, Imperial College and Delft University of Technology. These efforts aim at developing the technological applications of biology as the enabling science of the next century.

Professor Jefferson W. Tester continued as the Director of the Energy Laboratory throughout the academic year 1999–2000. He served as chair of the National Advisory Council of the DOE's National Renewable Energy Laboratory and served as a member of the National Research Council's committee evaluating the DOE's Office of Power Technologies R&D programs. Professor Tester also continued as a member of the advisory group for the Paul Scherrer Institute which is part of the Swiss Federal Institutes of Technology. He was appointed to Cornell University's Advisory Council, to Governor Cellucci's Advisory Council for the Massachusetts Renewable Energy Trust Fund and to chair the Technical Advisory Board of the China Energy Technology Project. Last year, he gave invited plenary lectures at the Annual National Association of Corrosion Engineers annual meeting, Waterloo University, International Symposium on Supercritical Fluids, and the Paul Scherrer Institute in Switzerland.

Professor Bernhardt Trout received an NSF CAREER award. He has continued theoretical work on natural gas production from hydrates, lean NO_x -trapping automotive catalysts, and zeolitic catalysis. This work is done in collaboration with the Department of Energy, Ford Motor Company, and Chevron Technology Company, in addition to experimental groups at several major universities. He has recently begun a project with Professor Daniel I.C. Wang on the effects of solvation structure on protein stabilization.

Professor Daniel I. C. Wang was the 1999–2000 Ashton Cary Lecturer at the Department of Chemical Engineering, Georgia Institute of Technology. He also delivered the Inaugural Address at the "Frontiers of Biotechnology" in the Department of Chemical Engineering, MIT. Professor Wang was the Chairman of the Strategic Review Board on Biotechnology organized by Minister George Shieh-Chien Yang, Minister of State, Republic of China. He also chaired the International Advisory Panel for the Bioprocessing Technology Center, National University of Singapore. Professor Wang was invited to be on the Advisory Committee of the Biomedical Engineering Center, Industrial Technology Research Institute, Taiwan, Republic of China. Lastly, Professor Wang was a member of the National Research Council's Committee on Opportunities in Biotechnology for the US Army.

Professor K. Dane Wittrup joined the faculty as a two-key Professor in the Department of Chemical Engineering and the Division of Bioengineering and Environmental Health in August '99. He was elected a Fellow in the American Institute of Medical and Biological Engineers, and was named the University of New Mexico College of Engineering Distinguished Young Alumnus for 1999. He was invited to present the Colburn Lectureship at the University of Delaware, as well as ten other invited talks, including the NAE German-American Frontiers of Engineering, University of Connecticut, and University of Wisconsin/Madison. He currently serves on the national Awards Committee of AIChE.

Professor Jackie Y. Ying was named a TR100 Young Innovator by Technology Review in 1999, and she is the recipient of the 2000 American Institute of Chemical Engineers (AIChE) Allan P. Colburn Award for excellence in publications. She delivered sixteen invited lectures at various international conferences and national meetings during the past year, including the plenary lecture at the 14th International Symposium on Industrial Crystallization in U.K. She served as the Chair of the Engineering Foundation Conference on Processing and Catalytic/Chemical Properties of Nanostructured Materials, and as the Co-Chair of the American Ceramic Society Symposium on Self-Assembled Ceramics via Complex Fluids. Professor Ying was an invited seminar speaker at the University of Cambridge, University of Colorado, Brigham Young University, Princeton University, and Georgia Institute of Technology. She was recently appointed as an Advisory Editor of Molecular and Chemical Sciences and an Editorial Board member of Journal of Metastable and Nanostructured Materials, and serves on the editorial boards of four other journals/book series. Professor Ying is a Director of the AIChE Materials Engineering and Sciences Division, and an Executive Committee Member of the American Chemical Society Colloid and Surface Chemistry Division. She is chairing the new Singapore-MIT Alliance Program on Molecular Engineering of Biological and Chemical Systems.

RESEARCH HIGHLIGHTS

Biopharmaceutical Protein Engineering

The new generation of biotechnological protein-based drugs includes monoclonal antibodies such as Herceptin and Rituxan for the treatment of breast cancer and lymphoma, respectively. Over 100 such antibodies are currently being evaluated in clinical trials, representing an extraordinary wave of new therapeutic "magic bullets" in the pipeline for treatment of cancer, autoimmune, and cardiovascular diseases. All antibodies function by binding specifically to a particular biomolecular target, and a key leverage point for improving the efficacy of such drugs is often to increase the strength of that binding interaction.

Professor Wittrup's group has developed a method for engineering such protein recognition properties, by a process termed "directed evolution." In essence, a Darwinian competition is established in the test tube amongst a collection of over 10^6 protein mutants, each displayed on the surface of a single yeast cell. By a quantitatively optimized procedure, the best mutants are isolated and mutated again, and the cycle of mutation and selection is repeated until the desired binding objective is reached. In model studies, an antibody that originally bound its target with a dissociation half life of approximately one minute was engineered to bind with a dissociation half-life of over five days. Wittrup's group is now extending this approach to therapeutically relevant targets, having established collaborations with clinical investigators in the areas of colon cancer, lymphoma, liver cancer and breast cancer.

Molecular Engineering of Surfaces

Professor Laibinis and his group have been developing a variety of active surfaces that by their design offer function and provide new properties as a result of molecular-level engineering. A recurring feature of their work is how nanoscopic changes in the structure and composition of an interface can provide dramatic change in surface properties. Adsorption, adhesion, and wetting are examples where molecular (and some times even atomic) additions to a surface can produce visual changes in these properties. Such changes can provide new levels of activity to a surface. In a recent example, the Laibinis group has prepared surfaces with reactive nucleating sites for the spontaneous and directed growth of polymer films from these surfaces. These films provide new levels of control for generating conducting polymer films on semiconductor surfaces and for producing patterned resist layers on surfaces for lithography.

The reactive nature of a surface can be tailored with exquisite control to perform large-scale operations. By tailoring surfaces to express CO_2H groups, the Laibinis group has developed methods based on self-assembly that can cause liquid droplets to spontaneously move on surfaces in specified directions and along desired paths. These self-propelled drops can move on the surface at velocities up to 1 cm/s and do so by converting surface energies to kinetic energies. This method is envisioned as a pump-less strategy for delivering liquids within microfluidic devices. In another development, the Laibinis group has been able to electroplate a single layer of silver onto a gold electrode and produce a sensor for measuring the chloride, bromide, and iodide concentrations in dilute solutions. The silver layer provides binding sites for the halides and produces distinct signals each time one of these halides adsorbs onto one of the silver atoms on the gold surface. The sensor is amenable to miniaturization, and its ability to generate three species by a single electrode is noteworthy. Its operation comes from a sub-nanometer change in the electrode surface.

The Laibinis group has also begun efforts to graft biomolecules to surfaces for sensing operations. A recent tool for genomic diagnostics is the gene chip, and a current challenge for this technology is the ability to controllably immobilize long DNA strands to their surface. By relying on base pairing as a strategy for self-assembling DNA strands to a surface, a new method has been developed that generates end-grafted single-stranded DNA molecules on surfaces that are hundreds (rather than tens) of base units in length. These DNA brush structures offer high efficiency for characterizing the sequence of unknown DNA molecules and allow screening of a wider genetic sequence space than done by available methods.

Highly Selective Control of the Dynamics of Heterogeneous Processes

Heterogeneous processes are of utmost importance and are practically omnipresent in the chemical industry. They include catalysis, adsorptive separations, and dissolution and growth of solids. Nevertheless, our understanding of these processes is primitive, and thus our ability to control them is limited. For example, solid-liquid and solid-gas interfaces are generally considered to be rigid; heterogeneous catalysts are modeled as a collection of one or two sites with static reactivites; and nucleation, growth, and dissolution of solids in liquids can be modeled only roughly, generally by assuming diffusive control or first-order reaction processes. On the other hand, these assumptions and models can be at best only rough approximations or heuristic rules that in the end limit our ability to model and thus control heterogeneous processes. Professor Trout's group is developing a molecular-level understanding of these processes and using this understanding to control processes and to develop catalysts with unprecedented selectivity. Our ability to do this is based on the use of quantum mechanical and statistical mechanical computational methodologies.

We are working with Ford Motor Company to develop a new generation of highly selective automotive catalysts, called lean-NO_x catalysts. These catalysts would lead to up to a 10-fold decrease in automotive emissions, but are currently unusable because sulfur, even in very low concentrations, poisons them. We have shown that morphology and particle size can affect the energy of adsorption of chemical species by up to 50 kcal/mol. Currently, we are determining the effect of these changes on the reactivity of these catalysts in order to promote beneficial reactions, while hindering reactions that lead to sulfur poisoning. We are also working on hydrocarbon reactions in zeolites, and have shown that charged species can be mobile inside the zeolite, which acts as a "solvent." In addition, we have elucidated various reaction mechanisms involved in the synthesis of olefins.

We are also working on the modeling of clathrate-hydrates joint with Professor Jefferson W. Tester in the Energy Laboratory and the Department of Energy. Clathrate-hydrates are ice-like materials that trap small molecules, such as methane or CO_2 at high concentrations. There is thought to be up to 1000 times more energy in methane clathrate-hydrates than in all other fossil fuels combined, and thus, we are working on ways of destabilizing them to extract the methane. In addition, CO_2 clathrate-hydrates may serve as a way of sequestering and/or storing CO_2, but a basic

understanding of the formation and dissolution of these materials is lacking, and we are our understanding of these. We are also developing and applying methodologies to study heterogeneous processes on ice particles that lead to ozone depletion in the stratosphere. This work is joint with Prof. Mario Molina. Finally, together with Professor Daniel I. C. Wang, we are working on the stabilization of therapeutic proteins via adjusting the local solvation structure.

DEPARTMENTAL AWARDS

The Chemical Engineering department's annual Awards Ceremony was held on Monday, May 8, 2000, in Gilliland Auditorium with Professor and department Head Robert C. Armstrong presiding. The following awards were presented:

In conjunction with the Student Financial Aid Office, the James E. Cunningham '57 Scholarship to Akaniyene E. Umoh, a junior from Providence, RI; and the John H. Dessauer Scholarship to Deepa R. Patel, a junior from Katy, TX.

Merck Fellowships were acknowledged for recipients Nganfong Huang, a sophomore from Brooklyn, NY, and Luwam G. Semere, a junior from Buffalo, NY.

The Dow Chemical Company Outstanding Junior Award recipient was Agnieszka N. Stachowiak, a junior from Ann Arbor, MI, for her balanced record of achievement in academics and campus professional and social organizations, as well as work experience.

The Robert T. Haslam Cup was awarded to Matthew J. Alvarado, a senior from Raymore, MO, for outstanding professional promise in chemical engineering.

The Roger de Friez Hunneman Prize, the oldest prize in the department (begun in 1927), was awarded to Lin Shi, a senior from El Monte, CA, in recognition of outstanding scholarship and research.

The Edward W. Merrill Outstanding Teaching Assistant Awards were presented to Michael J. Buchanan, a graduate student from Farmington Hills, MI, and Caroline P. Chen, a graduate student from Englewood, CO, for excellence in teaching in an undergraduate subject (10.37/Spring 2000).

Chemical Engineering department Special Service Awards were given to Brian D. Harms, a graduate student from Prior Lake, MN; Daniel D. Burkey, a graduate student from Doylestown, PA; Geoffrey D. Moeser, a graduate student from Burlington, Ontario; Canada, Bryant R.McLaughlin, a senior from Santa Ana, CA; and Janet E. Fischer, Graduate Administrator, for their unselfish contributions to the success of departmental activities.

The Chemical Engineering "ROCK" Award for outstanding athletics, as voted by the graduate students of the department, went to Joshua D. Taylor, a graduate student from Rancho Cordova, CA.

The Outstanding Employee Award was presented to Patricia A. Sampson, an Administrative Assistant in Chemical Engineering Headquarters, for her exceptional service to the departmental faculty, staff, and students. The Outstanding Faculty Award from the graduate students was presented to Professor Daniel Blankschtein. Undergraduate students in the department presented an Outstanding Faculty Award to Professor C. Michael Mohr.

An Individual Accomplishment Citation was presented to Christina M. Wilbert, a junior from Ada, MI, for her outstanding contributions to departmental life. Wilbert was the recipient of the fifth offering of this special award, and received a personalized citation signed by the department Head.

Professor Armstrong acknowledged departmental recipients of awards from the MIT Awards Convocation held on May 2nd. Those receiving Institute honors included Ronald E. McNair Scholarship Awardees, Carla M. Merritt, a junior from Raleigh, NC, and Stephany C. Espy, a junior from Decatur, GA.

More information about this department can be found on the World Wide Web at http://web.mit.edu/cheme/www/Titlepage.html.

Robert C. Armstrong

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

The Department of Civil and Environmental Engineering hosted the New Millennium Colloquium on the Future of Civil and Environmental Engineering last March 19–21, 2000. Chaired by Professor Frank E. Perkins, it was an extraordinary event with over 250 participants, including representatives, mostly department heads, of over 75 Civil and Environmental Engineering Programs throughout the nation and the world. Two university presidents, the president of the American Society of Civil Engineers and the CEO of ITT Industries led a star-studded program and debate that should define the New Civil and Environmental Engineer.

It is impossible to detail outcomes here; nevertheless some key areas of consensus resulting from the Colloquium were:

- The art of engineering and the engineering art are inseparable ideas in the mind of the creative problem solver, designer, and builder.
- The slogan "engineering for life" highlights the value added by engineering to society and the need to constantly re-educate and re-invent ourselves over a lifelong career.
- The profession must find ways to innovate more and to bring innovations to practice faster.
- Sustainability and environment are business opportunities, not only matters of public responsibility.
- Information technology is the most prevalent force changing the way we practice civil and environmental engineering.
- There should be a "revolving door" between industry and academia.
- The first professional degree in Civil and Environmental Engineering should be the Masters of Engineering.
- The Profession must constantly show its relevance to society. It must do so with excitement and innovation.
- We must recognize women and minorities as the future of our professional ranks.

It was satisfying to see that the Colloquium deliberations overlapped very well with the department's new Strategic Plan which was published for the Colloquium.

Our motto, "We love to make things happen," exemplifies the dynamic innovative spirit that dictates our actions. Our mission is to provide the skills and foundations for lifelong learning and growth focussing in three core areas: the built environment, the natural environment, and information and engineering systems.

We set seven major goals:

- Align undergraduate and graduate programs with thrust areas: development and sustainability, information technology, system design and integration, and physical infrastructure.
- Mobilize existing and develop new resources for research.
- Advance the Masters in Engineering as a first professional degree.
- Launch new research and education initiatives with a system-wide view of engineering in collaboration with the Engineering Systems Division.
- Implement a creative resource development campaign.
- Unify the Department in an environmentally friendly new building.
- Continue and strengthen our efforts to hire women and minorities to faculty ranks.

Following the Colloquium the CEE Department held a memorable Alumni/ae Reunion. Over 300 former students and friends joined us to celebrate the past and the future. We announced, as planned, the Donald and Martha Harleman Professorship, funded with the contributions of some 300 friends over last year.

We continue to hire and develop extraordinary young faculty. This year we hired Professor David Simchi-Levi as a tenured full professor. He is the first faculty member hired into a dual appointment between a department and the Engineering Systems Division. Professors Elfatih Eltahir and Heidi Nepf were granted tenure. Professors Dara Entekhabi and Andrew Whittle were promoted to full professors.

UNDERGRADUATE EDUCATION

Although this coming year we will see a small rebound in undergraduate enrollment, it continues to be our main source of concern.

Cyclical fluctuations in CEE enrollment (as is also the case in other engineering departments) are well documented, but we feel that changes have occurred that alter the enrollment models. The explosion of information technology and associated activity and wealth is the dominant new factor. Within MIT, the admission process and the nonlinear effect of peer influence in the choice of majors (i.e., the more of one major, the more you will recruit to that same major) makes it very hard to alter trends. Nevertheless we remain very committed to undergraduate education in Civil and Environmental Engineering and to the idea of servicing the MIT undergraduate population. Our new curricula provide quality education and is responsive to a new market. We are exploring new concepts for Institute-wide offerings in the area of Information Technology.

Last year we pursued a multi-pronged strategy to project the excitement and opportunities in Civil and Environmental Engineering to MIT undergraduates. These included writing to the admitted pool of students, two open houses, offering a study trip to the Everglades, publicizing the many available job opportunities, and guaranteeing a summer internship. The latter program has been extremely successful with many participating companies willing to hire our students. More important is the on-going implementation of the new curricula for both undergraduate degrees. These are exciting, problem-driven, learning-by-doing curricula. The first class will graduate next year.

Our Strategic Plan supports the idea of the Masters of Engineering as a first professional degree. Undergraduate education must be the solid cornerstone to additional professional studies of ever-expanding nature. To support this concept, the Department has developed a policy of automatic and seamless admission and transition of our undergraduates into our M.Eng. program, if their career grade point average exceeds a threshold. We are seeing increasing interest in this program from our undergraduates.

GRADUATE EDUCATION

Graduate education continues to thrive within the Department. In contrast to many other engineering departments, Civil and Environmental Engineering emphasizes the Masters program as the ideal first professional degree. It accounts for 162 of our 279 graduate students. The very successful Masters of Engineering program graduated its fifth class of 47 students. The graduates are in very high demand and receive well-paid multiple offers. Next year the program will go over its projected enrollment objectives with an enrollment close to 72 students.

Our Strategic Plan calls for increasing fellowship support for graduate students, in particular doctoral candidates (M.Eng. students are self supported except for a handful of half tuition fellowships available on a merit basis). The Department, with the help of initiatives from the School and the Institute, has been making progress on this front. Thirty-two fellowships were granted this year to incoming graduate students. Of all our graduate students, 58 were supported by fellowships, 177 by Research Assistantships, 50 by Teaching Assistantships and 41 were self-supported or received support from sources beyond our control.

This year's admission cycle went very well. We received a total of 3608 inquiries, compared to 3204 last year. These translated to 590 applicants (487 last year). The proportion of US citizen applicants remains at about 31%, or 181 applicants. We would like to increase this proportion. Fifty-two percent of applicants were offered admission and a total of 155 individuals have accepted the offer. Our biggest competitors, based on surveys of declined offers, are Stanford and Berkeley that together wooed 42 individuals we had also admitted.

FACULTY NOTES

Professor Kevin Aramatunga received a NSF Career Award this year.

Professor Cynthia Barnhart, Keith Ware (UPS) and Andrew Armacost (ORC Ph.D. student) received the Best Conference Paper Award for a paper entitled, "Planning Models for Designing Express Shipment Service Networks," presented at the AGIFORS 39th Annual Symposium, New Orleans, LA.

The Hispanic Engineer National Achievement Awards Conference (HENAAC) selected Rafael Bras to receive the Albert Baez, Jr. Award and the Outstanding Educator Award. "The essence of this award program is to present accomplished role models to our nation." This year's Martin Luther King Leadership Award for faculty members was given to Professor Rafael Bras at MIT's annual MLK program.

Professor Ismail Chabini received the NSF CAREER Award and appointed an associate editor of the *IEEE Transactions on Intelligent Transportation Systems.*

"Policy Studies in Engineering Education-A Tribute to Professor Richard de Neufville," an afternoon of talks held on May 5, commemorated Professor de Neufville's 25 years with the Technology and Policy Program.

At the American Institute of Hydrology annual meeting in November 1999, Professor Peter Eagleson was given the Ray K. Linsley Award for outstanding contributions to hydrology.

Honors given at the annual CEE Department dinner in September included Effective Teaching Awards to Professors Sarah Slaughter and Philip Gschwend. An outstanding Service to the department award went to Professor Jerome Connor.

Three NSF Faculty Early Career Development awards were presented to CEE faculty. Professor Patricia Culligan's research project is on the use of the geotechnical centrifuge for physical modeling of geo-environmental and geotechnical problems. Professor Charles Harvey will revisit two basic processes in hydrogeology: solute transport in heterogeneous formations and chemical mixing in porous media. Professor Feniosky Peña-Mora will study collaborative negotiation methodology for large-scale infrastructure projects.

Professor Elfatih A. B. Eltahir was awarded the 1999 Kuwait Prize in Applied Sciences (Climate Change) by the Kuwait Foundation for the Advancement of Science. Professor Eltahir was promoted to Associate Professor with tenure.

Professor Dara Entekhabi was promoted to Full Professor.

Professor Lynn W. Gelhar has been appointed to the National Academy of Sciences National Research Council Committee that is reviewing the environmental remediation science and technology activities at the Department of Energy's Hanford site in eastern Washington.

Professor Eduardo Kausel received the Alexander von Humboldt Research Prize from the Federal Republic of Germany which is among the most prestigious research awards given by the German government to foreign nationals. *Wave Motion in Earthquake Engineering* by Professor Eduardo Kausel and George Manolis (Aristotle University of Thessaloniki, Greece) was recently published by the MIT Press.

At the ASCE annual meeting in October in Charlotte, NC, Professor Charles Ladd received the Karl Terzaghi Award to recognize decades of innovative research dealing with the strength properties of soft clays and consultation on projects involving structures placed on such soils.

Professor Heidi Nepf's research in wetland hydrodynamics will be a feature article in an upcoming issue of *Natural New England* magazine. Professor Heidi Nepf was promoted to Associate Professor with tenure.

Professor Feniosky Peña-Mora received a Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the US government on outstanding scientists and engineers in the early stages of establishing their independent research careers.

One of the two new holders of the 2000 Doherty Professorship in Ocean Utilization from the MIT Sea Grant College Program is Professor Martin Polz. He develops molecular approaches to understand the structure and function of microbial communities as key elements of marine and aquatic ecosystems.

The *Boston Business Journal* has declared senior lecturer Fred Salvucci '61 & '62 to be one of the most influential Bostonians of the 20th century.

Professor Joseph Sussman's *Introduction to Transportation Systems*, an up-to-date survey of modern transportation, was published by Artech House of Boston.

Professor Andrew Whittle was promoted to Full Professor.

RESEARCH HIGHLIGHTS

In response to our Strategic Thrusts a group of faculty led by Professors Kevin Amaratunga and Franz Ulm have developed the concept of I-City, a vision of the city of the future. The premise is that the building, operating and maintenance of infrastructure will soon be based on extensive monitoring and sampling; on signal processing for condition assessment; on simulation and prediction at a variety of scales and resolution; and on decision making and control based on observations and modeling. The City of the Future will intensively use information for managing its built and natural environment.The I-City concept is under discussion with a variety of international partners. The concept will be tested as part of a Mircosoft I-Campus project that will monitor the state of several locations around the MIT campus and use the information in laboratory experiences.

CEE faculty are major players in two other I-Campus initiatives. Professors Chiang C. Mei and Heidi Nepf are developing a modular, web-based curriculum for fluid mechanics that is designed to take advantage of content leveraging by creating pedogogical and software methodologies to tailor the same "Active Learning Tools to Enrich Engineering Education" project. Professor John Miller has commenced with an ambitious attempt to form the American Infrastructure Consortium, an inter-disciplinary group of commercial, government, and non-governmental organizations focused on improving the quality and cost performance of collections of public and private infrastructure facilities. Professors Charles Harvey and Harold Hemond have initiated a major project, funded by NSF and the Alliance for Global Sustainability, on the arsenic contamination of the well water supply of Bangladesh, probably one of the largest public health crises of modern times.

The department is a leading player in the formulation of a major environmental initiative on campus, The Earth Systems Institute: The New Ecology.

DEPARTMENTAL AWARDS AND OTHER SPECIAL RECOGNITION

Four CEE students were honored at the 2000 MIT Awards Convocation in May: Sarah McDougal '00 (1-E) received the William L. Stewart, Jr. Award for her outstanding contribution to extracurricular activities and events at MIT last year. For excellence in athletic competition (multiple fencing championships), Caroline Purcell '02 (1-C) won the Betsy Schumacker Award. Hiep Nguyen, a graduate student in Construction Engineering and Management, won a first place Harold and Arlene Schnitzer Prize in the Visual Arts, for demonstrating excellence in creating a body of work in the visual arts. Anne T. McLeod '00 (1-C) received the Priscilla King Gray Award for Public Service for being exceptionally committed to public service at MIT and its surrounding communities.

Alyssa Thorvaldsen '00 won the Phillip Trussel Prize for a female athlete who demonstrates "skill, sportsmanship and levity."

Theater Arts presented a special plaque to graduate student Kortney Adams in honor of her performances in several productions as well as her "craftsmanship of particular distinction" for her work in the MIT Costume Shop.

Walid Fayad won this year's Guanassia Prize which goes to a graduate student from either the Ecole Centrale or the Lycee Louis le Grand in France.

Nathan L. Burnham '00 received the Steinberg Prize, awarded to an undergraduate for academic achievement and demonstrable interest in construction management.

The Richard Lee Russel Award for an outstanding or continuing undergraduate in CEE who plans to continue with graduate study went to Yat Lun Wesley Choi '00.

Amber E. Crabbe '00 and Nathaniel J. Grier '00 shared the Leo '24 and Mary Grossman Award, given to an undergraduate with a strong interest in transportation and a strong academic record.

A special award from the Department went to Anne T. McLeod '00 in recognition of her academic achievement and outstanding service to the Institute.

An Effective Teaching Assistant Award went to Laurent Levy for his work with 1.010 Uncertainty in Engineering in fall 1998.

Outstanding Service to the Department awards went to graduate student Salal Humair (TA for 1.00 Introduction to Computers and Engineering Problem Solving), and Yasmin Rehmanjee '00.

Among the new MIT Phi Beta Kappa initiates are CEE graduating seniors Anne McLeod and Jantrue Ting.

The first Charles "Harrison" Smith III Memorial Award was given to Terence Emmert, a CEE graduate student and a member of the Leaders for Manufacturing Class of 2001. The award gives the class the opportunity to recognize the efforts of those classmates who have improved the LMF experience both within and outside of the program.

Writing prizes were bestowed on several CEE students by the Program in Writing and Humanistic Studies. Yanni Kosta Tsipis '01 (CEE & Urban Planning) received first place in the Boit Manuscript Prize essay category for "The Last Road to Boston." Samidh Chakrabarti '01 (CEE & EECS) won second place in the Dewitt Wallace Prizes for Science Writing for the Public with "Message in a Bottle," "Ladybug," a short story by Tobert Ziemian '00, won an honorable mention in the Robert A. Boit Writing Prize.

Three of Professor John Williams' graduate students, Abel Sanchez, Hai Ning and Jeff Chi, have received the McGovern Award, given by Patrick J. McGovern of International Data Group for "outstanding achievement that promoted the quality and spirit of entrepreneurialism at MIT in 1999–2000." They organized and launched e-MIT, the entrepreneurialship portal that enables the MIT community and friends of the Institute to find in one place a variety of entrepreneurial events programs, resources, and venture.

Two of the new members of Tau Beta Pi, the national engineering honor society to award excellence and integrity, are Matthew Howes '99 and Yasmin Rehmanjee '00.

For demonstrating "remarkable inventiveness and serving as an inspiring science and technology role model for young Americans," Amy Smith won the 6th annual Lemelson-MIT Program student prize for inventiveness. A graduate student in the Technology and Policy Program who has worked with Professor Herbert Einstein, she developed a phase-change incubator which does not require electricity.

For the second year in a row, graduate student Jeremy Pal was the top fundraiser at the annual CEE Telethon. The 34 callers contacted 304 alumni and secured 216 gifts and pledges totaling $25,822. Heartfelt thanks to everyone who participated and contributed!

More information about the Department of Civil and Environmental Engineering can be found on the World Wide Web at http//web.mit.edu/civenv/.

Rafael L. Bras

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

The past year, like most years, was a busy one for EECS faculty, staff, and students. A number of exciting new faculty members, including three women, joined the department and we launched a number of new educational and research initiatives.

The separtment's undergraduate and master of engineering programs continue to thrive, with total enrollment again at an all time high. This has placed a considerable burden on parts of our faculty. We have responded by slightly increased hiring and by instituting new policies that will lead to a slight reduction in the size of our master of engineering program.

Despite the high overall enrollment, our undergraduate electrical engineering program continues to be considerably smaller than it has historically been. The drop in interest in pure electrical engineering is a nation wide trend. Interestingly, however, our largest undergraduate program is not our computer science program (as at many other universities) but instead our program that combines electrical engineering and computer science. This can be viewed as an affirmation of the value of a broad-based education that encompasses both electrical engineering and computer science.

The doctoral program too is healthy. Its size has remained almost constant, though we plan to grow slightly over the next few years. We continue to be extremely selective in our admissions process, especially in Areas I and II. In September we made a number of significant changes to our doctoral programs. These included a more flexible qualification process and a teaching requirement.

Under the leadership of Associate Department Head Rafael Reif, we have greatly increased our interactions with industry. Most notably, we launched our Industrial Connections Program (ICP). This program provides a formal mechanism for interaction between member companies and EECS students. The goal is to facilitate efficient communication between the EECS student community and the business world. Membership in the ICP is open to companies with a strong commitment to electrical engineering and computing.

Under the leadership of Associate Department Head Tomás Lozano-Pérez, we have launched a number of educational experiments. Some of these experiments have been aimed primarily at improving the quality of the educational experience. Others have been aimed primarily at improving the efficiency with which we deliver education. The preliminary results are very encouraging, and will result in some major changes over the next few years.

Finally, the Ray and Maria Stata Center is a step closer to reality. Ground has been broken, and the current schedule calls for us to occupy it in 2003.

UNDERGRADUATE PROGRAM

Enrollment of undergraduates averaged 1025 in 1999–2000, close to that of 1998–1999, with 16 percent in the Electrical Engineering Program, 41% in the Computer Science Program, and 35% in the Electrical Engineering and Computer Science Program. From the Class of 2002, 360 students were enrolled in Course VI, the same as the preceding year. About 380 students from the Class of 2003 have so far selected Course VI, with 13% choosing 6-1, 57% 6-2, and 30% choosing 6-3.

The Master of Engineering (M.Eng.) program entered its fourth year with 250 students.

The following prizes and awards were won by our students:

The Ernest A. Guillemin Thesis Competition for outstanding performances on a Master of Engineering theses in Electrical Engineering were won by Brian B. Graham of Seattle, WA, Serena Chan of Brooklyn, NY, and Tommy Ng of Cambridge, MA.

The David Adler Memorial Thesis Prize for outstanding performance on an Undergraduate Thesis in Electrical Engineering was presented to Peggy B. Chen of Cambridge, MA.

The Charles and Jennifer Johnson Theses Prizes for outstanding performance on Master of Engineering thesis in computer science were awarded to Jeremy J. Lilley of Cambridge, MA and Ian R. Schechter of Cambridge, MA.

The Morris Joseph Levin Awards for Best MasterWorks Oral Theses Presentations were awarded to William Adjie-Winoto of Boston, MA, Eladio C. Arvelo of San Diego, CA, Matthew S. DeBergalis of Cambridge, MA, Dario Gil of Cambridge, MA, Shawn Hwang of Cambridge, MA, Christopher Lin of Cambridge, MA and Yu-Ming Lin also of Cambridge, MA.

The William A. Martin Memorial Thesis Prize for outstanding performance on a Master of Engineering thesis in computer science was presented to Peter M. Ju of Winchester, MA.

The George C. Newton Prizes for the best undergraduate laboratory projects were awarded to Jason Timpe of Cambridge, MA, Nicholas C. Homer of Boston, MA, and Philip W. Juang of Cincinnati, OH.

The Robert A. Fano UROP Awards were given to Raffi C. Krikorian of New City, NY and Bradley Kaanta of Colchester, VT.

The Northern Telecom/BNR Project Awards were made to Charles B. Lee, Sandia Ren, Xiaolan, Nisha Checka and Yanlok Charlotte Lau all of Cambridge, MA.

The David A. Chanen Writing Award was given to Kenneth Lu of Cambridge, MA.

The Anna Pogosyants UROP Award was presented to Michael Tsai of Cambridge, MA.

The Department Special Awards were presented to CheeWee NG of Cambridge, MA, and Jacob Strauss of Needham, MA.

The Norman R. Carson Outstanding Junior Award was given to Ishwar Sivakumar of Cambridge, MA

The Outstanding Tutor Award was presented to Shuley Nakamura of Pebble Beach, CA.

GRADUATE PROGRAM

In September 1999, there were 802 graduate students enrolled in the department. About 25 percent of the total were foreign nationals. The department supported 440 Research Assistants and 110 Teaching Assistants. In addition, there were 191 fellowships including 50 National Science Foundation Fellows, and 14 Department of Defense Fellows. The remaining students had industrial or foreign support or were using their own funds.

During 1999, the department awarded 69 Master of Science degrees, 2 Electrical Engineer degrees and 75 Doctoral degrees.

The department received 2043 applications for the 1999–00 year, a slight increase from 1998. The applications continue to be generally excellent and 287 were admitted for 1999 (February, June and September), of whom 129 registered in September.

A number of awards were made to graduate students for excellence in teaching. Maya R. Said of Cambridge, MA, received the Carlton E. Tucker Award and Mohammed Saeed of No. Andover, MA, received the Harold L. Hazen Award. The Frederick C. Hennie III Awards for excellence in teaching were presented to Albert M. Chan and Amy N. Englehart both of Cambridge, MA. The George M. Sprowls Awards for outstanding research contributions in the field of electronic computer and investigation research were presented to Dawson Engler recently appointed to the faculty of Stanford University, Stanford, CA, Matteo Frigo of Padova, Italy, Daniele Micciancio of San Diego, CA, and Andrew Myers recently appointed to me faculty at Cornell University, Ithaca, NY.

VI-A INTERNSHIP PROGRAM

The department's VI-A Internship Program is in its 83rd year and continues to feel the competition from the on-campus M.Eng. program and the appeal of start-up companies. This year 73 students applied during the annual Orientation and Selection process and 41 were selected as members of the incoming VI-A class. To compare, in 1999 109 students applied and 67 were selected while 1998 120 students applied and about 58 were selected. Since the last Report, approximately 22 students have withdrawn from the VI-A program as they felt their needs were

better matched with the opportunities available on-campus. In spite of this trend, the VI-A program continues to provide excellent educational opportunities as the companies have ensured their commitment of challenging assignments. Even though enrollment has decreased, our philosophy is to have a small but excellent program rather than a larger but mediocre program.

Four companies—American International Group, AT&T Labs., Hewlett-Packard and Rational Software Corporation—did not take new students this year, but will continue with those students selected in previous years. Although other companies have expressed interest in participating in the program, the number may have to be limited due to the small student enrollment.

In June, 34 VI-A students received the M.Eng. degree having completed all their company assignments and Institute degree requirements. There were 35 VI-A students who were awarded their bachelor's degree and most of them will continue into the graduate phase of the program.

Many honors and awards continue to be bestowed on VI-A students. Manu Sridharan (IBM Corp.) was one of the 26 sophomores and juniors who was selected as a Burchard Scholar in the School of Humanities and Social Science for 2000. These awards are given to students who demonstrate unusual abilities and academic excellence in the humanities, arts, and social sciences.

At the Institute Awards Convocation Sean J. Sutherland (COMSAT Labs.) was one of the recipients of the Laya and Jerome B. Wiesner Award for achievement in the creative arts and in the performing arts.

At the annual Department Awards Reception held at the Museum Fine Arts in Boston, the following VI-A students were honored: Maya R. Said (Xerox/PARC) received the Carlton E. Tucker Teaching Award; Yanlok Charlotte Lau (Analog Devices) received a Northern Telecom/BNR Project Award; Eladio C. Arvelo (QUALCOMM) and Shawn M. Hwang (Agilent Technologies) each received a Morris Joseph Levin Award for a Best MasterWorks Oral Thesis Presentation; Jason T. Timpe (Lockheed Martin IR Imaging Systems), Nicholas C. Homer (Charles Stark Draper Laboratory) and Philip W. Juang (Charles Stark Draper Laboratory) received the George C. Newton Undergraduate Laboratory Prizes; Peter M. Ju (AT&T Labs) received the Wililam A. Martin Memorial Thesis Prize; and Serena Chan (MIT Lincoln Laboratory) was one of the Second Prize winners of the Ernst A. Guillemin Thesis Award.

The School of Engineering awarded Warit Wichakool (QUALCOMM) a Reinhold Rudenerg Memorial Fund Award which is given to students with outstanding undergraduate theses relating to energy conversion.

Sripriya Natarajan (Agilent Technologies) won second prize in the contest for the WHS Prize for Engineering Writing.

VI-A students continue to excel in their studies as Hau Hwang (AT&T Labs.) and Aaron Ucko (AT&T Labs.) were elected members of Phi Beta Kappa; Eta Kappa Nu, the Electrical Engineering National Honor Society, initiated 111 new members of whom 25 were VI-As; and of the 114 students from the School of Engineering elected to Tau Beta Pi, the National Engineering Honorary, 14 were VI-A's.

FACULTY

Six new faculty members joined the department this year:

Trevor J. Darrell, Assistant Professor of Computer Science and Engineering, received his Ph.D. from MIT.

Judy L. Hoyt, Associate Professor of Electrical Engineering, received her Ph.D. at Stanford University.

Leslie P. Kaelbling, Professor of Computer Science and Engineering, received her Ph.D. at Stanford University.

Robert T. Morris, Assistant Professor of Computer Science and Engineering, received his Ph.D. at Harvard University.

Muriel Medard, Assistant Professor of Electrical Engineering, received her Ph.D. at MIT.

Rahul Sarpeshkar, Assistant Professor of Electrical Engineering, received his Ph.D. from the California Institute of Technology.

Assistant Professors Rajeev Ram and Martin Rinard were promoted to Associate Professor.

Tenure was granted to Professors Akintunde I. Akinwande, Duane S. Boning, Anantha P. Chandrakasan, Amos Lapidoth, Steven B. Leeb and Madhu Sudan.

Rachel J. Bredemeier was promoted to the newly created position of EECS Communications Coordinator.

Faculty Awards and Honors
Assistant Professor Hari Balakrishnan received the 2000 NSF Career Award. He also received the IBM Faculty Partnership Award.

Assistant Professor John Chapin received the Presidential Early Career Award for Scientists and Engineers.

Professor Mildred Dresselhaus received the Nicholson Medal from the American Physical Society and the Women in Science Millennial Achievement Award. She was also awarded a Doctor *honoris causa* degree from the University of Leuven in Belgium. Professor Mildred Dresselhaus was nominated by President Clinton as Director of the Office of Science. She also received the 2000 Celsius Lecturer in Sweden.

Professor Robert Gallager was elected Fellow of the Industrial Engineering Consortium. He also received an IEEE Third Millenium Medal.

Professor Martha Gray was named the Edward Hood Taplin Chair in Medical Engineering.

Professor Eric Grimson was elected Fellow of the American Association for Artificial Intelligence.

Professor Alan Grodzinsky received the Class of 1960 Innovation in Education Award.

Professor Erich Ippen was awarded the Distinguished Engineering Alumnus Award from the University of California at Berkeley.

Associate Professor Daniel N. Jackson was named the Douglas T. Ross Career Development Associate Professor of Software Engineering.

Professor Frans Kaashoek was awarded the IEEE Course VI Outstanding Advisor Award.

Professor Leslie Kaelbling was elected Fellow of the American Association for Artificial Intelligence.

Professor John Kassakian received an IEEE Third Millenium Medal.

Professor James Kirtley received an IEEE Third Millenium Medal.

Professor Jin Kong received the 2000 S.T. Li Prize. He also received the IEEE Geoscience and Remote Sensing Society Distinguished Achievement Award.

Associate Professor Steven Leeb was nominated as a Discover Magazine Award Finalist.

Professor and Dean of the School of Engineering Thomas Magnanti was elected to the American Academy of Arts and Sciences.

Assistant Professor Leonard McMillan received the Ruth and Joel Spira Teaching Award.

Professor Albert Meyer was elected Fellow of the Association for Computing Machinery.

Professor Marvin Minsky received the R.W. Wood Prize of the American Optical Society.

Professor Sanjoy Mitter received the 2000 IEEE Control Systems Award.

Professor Alan Oppenheim received an IEEE Third Millenium Medal.

Professor Paul Penfield was named the Dugald C. Jackson Professor of Electrical Engineering. He was also presented with the Outstanding Service Award by NEEDHA (National Electrical Engineering Department Heads Association) and the IEEE Circuits and Systems Society Golden Jubilee Award.

Professor Rafael Reif received the Aristotle Award 2000 from the Semiconductor Research Corporation.

Professor Ronald Rivest was named the Andrew (1956) and Erna Viterbi Professor of Electrical Engineering and Computer Science.

Professor Jeffrey Shapiro was elected Fellow of the Institute of Physics and was named the Julius A. Stratton Professor of Electrical Engineering

Professor Kenneth Stevens received the National Medal of Science.

Professor Gerald Sussman was elected a Member of the National Academy of Engineering.

Professor Thomas Weiss received the Class of 1951 Fund for Excellence in Education Award, the Class of 1955 Fund for Excellence in Teaching Award, and the Class of 1972 Fund for Educational Innovation Award. He was also elected the John F. and Virginia B. Taplin Faculty Fellow in Health Sciences and Technology.

Professor Alan Willsky was named the Edwin Sibley Webster Professor of Electrical Engineering.

Professor Markus Zahn received the 2000 Ecole Superieure de Physique et de Chimie Industrielles (ESPCI) Medal for Paris Sciences.

The following faculty were on sabbatical for all or part of the year: Professor Dimitri P. Bertsekas, Professor Srinivas Devadas, Professor Robert C. Berwick, Professor Rodney A. Brooks, Professor Carl E. Hewitt, Professor James L. Kirtley, Professor Amos Lapidoth, Professor Charles E. Leiserson, Professor Barbara H. Liskov, Professor Paul L. Penfield, Jr., Professor Martin F. Schlecht, Professor Stephen D. Senturia, Professor Jeffrey H. Shapiro, Professor Charles G. Sodini, Professor Gerald J. Sussman, Professor Stephen A. Ward, Professor Cardinal Warde, Professor Gregory W. Wornell, and Professor Markus Zahn.

The department hosted seven visiting faculty:

Professor Sherra Kerns, from Vanderbilt University, hosted by Paul L. Penfield, Jr.

Assistant Professor Lisa G. McIlrath, from Northeastern University, hosted by Professor William E.L. Grimson.

Professor Johan E. Mooij, from Delft University, hosted by Professor Terry P. Orlando.

Professor Jose Moura, from Carnegie Mellon University, hosted by Professor Sanjoy K. Mitter.

Professor Manuela Veloso, from Carnegie Mellon University, hosted by Professor Rodney Brooks.

Professor Carl E. Hewitt retired from the faculty this year.

It is with deep sadness that we note the passing of Professor Jonthan Allen, Director of the Research Laboratory of Electronics.

More information about this department can be found on the World Wide Web at http://www-eecs.mit.edu/.

John V. Guttag

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

The Department of Materials Science and Engineering (DMSE) continues its intellectual and educational leadership, capturing the top position in the *US News and World Report* ranking of materials science departments nation-wide for the eleventh consecutive year. Five new, young faculty members have recently joined the ranks of the Department and a brief description of their backgrounds and fields of expertise can be found in the following pages. Department faculty and students continue to be honored with prestigious awards and medals from various professional societies and international organizations.

The department has undergone a smooth change of leadership, with Professor Suresh succeeding Professor Eagar as Department Head. Professor Eagar, who stepped down effective January 15, 2000 after five years as Department Head, will return to full-time teaching and research after a well-deserved sabbatical leave. Professor Allen was appointed Executive Officer effective April 2000 with primary responsibilities for educational programs and space.

The new department administration has implemented a number of major initiatives in the past six months. With enthusiastic support from DMSE faculty and the Institute, a one-year program oriented toward careers in industry and leading to a Master of Engineering (M.Eng.) degree in Materials Science and Engineering has been finalized. The first M.Eng. students will begin their classes in June 2001. A Ph.D. degree program in Biomaterials has been introduced in DMSE beginning Fall 2000, with an inaugural enrollment of three graduate students. Plans are underway for a new Nanomechanical Technology Laboratory; pledges of external donations total well over one million dollars. Major plans have been initiated for the establishment of a new graduate student lounge and new laboratories for research into Biomaterials and Computational Materials Science. The Department has also launched a campaign to raise funds for an endowed professorship to be named after Professor Merton C. Flemings. This was announced during the Symposium held at MIT in his honor in June 2000. The 2000–2001 academic year is marked by a large graduate student enrollment in DMSE, with an incoming class of 60 new graduate students, a sharp increase over last year's incoming class of 29.

Faculty Members from the Department continue to lead major Institute initiatives. The Singapore-MIT Alliance (SMA), co-directed by Professor Flemings, is developing new paradigms in global education and research interactions between MIT and the two Universities in Singapore. The Cambridge-MIT Institute (CMI), a global alliance with Cambridge University, is directed at MIT by Professor John B. Vander Sande. Professor Lionel C. Kimerling directs the Microphotonics Center, created with funding from Nanovation, Inc., to foster cutting-edge research in the area of microphotonics.

We were deeply saddened that former DMSE Professor David Kingery passed away this past June at his home in Wickford, Rhode Island. Professor Kingery, who is widely regarded as the "father of modern ceramics," was a faculty member in the department from 1951 to 1988. He contributed enormously to the intellectual strength and growth of the department.

UNDERGRADUATE EDUCATION

Our undergraduate enrollment remains steady at about 110 students and currently comprises 65% women, 8% underrepresented minorities, and 4% international students. Recruiting efforts to maintain our undergraduate student body are extensive, including participation in Academic Expo during Freshman Orientation, an Open House, the annual John Wulff Lecture, direct mailings to the freshman class, Freshman Advisor Seminars, and IAP Activities. Our III–B Internship Program continues to attract the majority of DMSE undergraduates. Through this program we have strengthened our interactions with companies and government laboratories in the US, Europe, and Asia while providing summer experiences relevant to the educational development of our undergraduates. Forty-seven DMSE students were placed at 27 host institutions during the Summer of 2000.

The Department's undergraduate program added two new restricted electives in biomaterials: Professor Anne Mayes' 3.051J, Materials for Biomedical Applications, and Professor Christine Ortiz's 3.052, Nanomechanics of Materials and Biomaterials, expanding the specialty subjects offered to our undergraduates.

Professor Lorna Gibson continues to chair the Undergraduate Study Abroad Committee and coordinate the activities of the Materials Undergraduate Study Exchange Program (MUSE). During academic year 1999–2000 the department had an active exchange of undergraduate students with Oxford University.

GRADUATE EDUCATION

The Department has a very healthy graduate student enrollment, currently 157. Approximately 26% of our graduate students are women and 2% are underrepresented minorities. As of February 2000, the distribution of students among our graduate degree programs was:

Degree Program	Percent Total Graduate Students
Ceramics	12.7%
Electronic Materials	28.7%
Materials Engineering	17.2%
Materials Science	15.9%
Metallurgy	8.3%
Polymers	17.2%

Two of our students were enrolled in the Technology and Policy Program (TPP) and eight were enrolled in the Leaders for Manufacturing Program (LFM). Seventeen of our Polymers students were enrolled in the Program for Polymer Science and Technology (PPST).

We continue to offer one-term and two-term fellowships to an increasing percentage of our domestic applicants. Nearly all undesignated gifts to the department fund endowed fellowships (including the Nicholas J. Grant Fellowship, the John F. Elliott Fellowship, the Ronald A. Kurtz Fellowship, the Gilbert Y. Chin Fellowship, the R. L. Coble Fellowship, the Carl M. Loeb Fellowship, the David V. Ragone Fellowship, the H. F. Taylor Fellowship, the H. H. Uhlig Graduate Fellowship, the Stuart Z. Uram Fellowship, the Class of '39 Fellowship, the Julian Szekely Fellowship, the Wenckus Fellowship, and the Department Endowed Fellowship). These fellowships provided one-term support for ten students in Fall 1999.

In addition to the above, we are the grateful recipients of a number of grants from corporations to aid our first year students. Our corporate supporters include TECHINT, SIDOR, Intel, and IBM. Many of our students have other outside fellowship support as well. Of the 35 domestic students expected to enter in the Fall of 2000 (over 58% of our incoming class), 22 will be supported by fellowships from the department, MIT, NSF, NDSEG, and U.S. Navy.

DMSE finalized a curriculum and obtained approval for a new Master of Engineering Degree in Materials. The program aims to create leaders in fast-growing materials engineering technology areas by laying a strong, graduate-level foundation in the fundamentals of the field. This foundation is followed by subjects that build expertise in particular areas of materials engineering. The program's capstone experience is student participation in engineering projects and technology assessment under the supervision of departmental faculty. Technology assessment and commercialization projects will be carried out at MIT, and some projects may be carried out at industrial sites. Applicants will be recruited in the coming academic year, and the first registrants in the program will begin studies in June 2001.

A new Ph.D. degree program in Biomaterials has been introduced in DMSE beginning Fall Semester 2000, with an inaugural enrollment of three graduate students. The program was initiated to address the growing student interest in a biomaterials-oriented graduate curriculum and the rising need for Ph.D.-level scientists and engineers who can apply the structure-property-processing paradigm to materials used in biomedical and biotechnological applications. The degree program subject requirements will include the DMSE core graduate curriculum plus two subjects chosen from the restricted electives: 3.96J, Biomaterials-Tissue Interactions; BEH.410J, Molecular, Cellular and Tissue Biomechanics; and new subject BEH.442, Molecular Structure of Biological Materials. Additional new subject offerings are anticipated within two years.

STUDENT ORGANIZATIONS

The current officers of the Society of Undergraduate Materials Students (SUMS) are Melissa Light, President; Elissa Schwartzfarb, Vice President; Joseph Louis, Treasurer; Elizabeth Maxwell, Secretary.

The Graduate Materials Council (GMC) officers for 2000–2001 are Krystyn Van Vliet, President; Ashley Predith, Vice President; Rob Bernstein, Treasurer; Todd Stefanik and Eric Wu, Athletic Chairs; Joanie Kertz and Marc Richard, Social Chairs; Doug Cannon and Mindy Tupper, DCGS Representatives; and Ryan Kershner, GSC Representative. The representatives to the degree panels are Michael Read (Biomaterials), Rebecca Scheidt (Ceramics), Ramkumar Krishnan (Electronic Materials), Ryan Kershner (Materials Engineering), Catherine Bishop (Materials Science), James Yurko (Metallurgy), Hartmut Rudmann (Polymers).

The Association for Materials Science Students (AMaSS) is an umbrella organization that fosters the growth of the various student chapters of materials science and engineering professional societies. Members of the Executive Committee are Andrew Gouldstone and Michael Shin, and Professor Sam Allen is the faculty advisor. Under AMaSS, several student chapters now maintain an active membership and a full calendar of events. The MIT joint student chapter of TMS/ASM is chaired by Krystyn Van Vliet and advised by Professor Ronald Latanision. The MIT student chapter of the Society for Biomaterials (SBM) is chaired by Toby Freyman, and is advised by Professor Ioannis Yannas and Dr. Myron Spector. The MIT student chapter of the Foundry Education Foundation (FEF) is chaired by James Yurko and advised by Professor Sam Allen. The MIT student chapter of the Materials Research Society (MRS) is chaired by Kevin Chen and advised by Professors Linn Hobbs and Mildred Dresselhaus. The MIT student chapter of the American Ceramic Society (ACerS) is chaired by Gary Maskaly and advised by Professor Yet-Ming Chiang.

RESEARCH HIGHLIGHTS

Research in Professor Allen's group is working to improve understanding of structure-property-processing relations in metal parts fabricated by three-dimensional printing, and in ferromagnetic shape-memory alloy actuators. Professor Carter and his students develop a wide range of computational approaches to understand fundamental aspects of microstructure development and their effects on materials properties in diverse materials that range from bone to solder. Professor Ceder's group has developed a methodology for calculating diffusivities in multi-component oxides with non-dilute diffusion and coupled it with continuum simulations for the transport and elastic deformation of macroscopic oxide particles. Professor Chiang and his students developed new bismuth perovskite single-crystal piezoelectrics with a broad range of actuation characteristics as potential replacements for current lead-based piezoelectric ceramics. Professor Cima's work focuses on the processing and fabrication of complex ceramic and electronic components via 3-Dimensional Printing and microfabrication/micromolding, biomedical applications and controlled-release drug delivery (3D Printing of drug tablets and biomedical devices, microchip delivery of pharmaceuticals, etc.), and thin-film superconductors. Professor Clark coordinated a reorganization of the International Motor Vehicle Program.

In Professor Eagar's group, a new method of scaling order-of-magnitude solutions of complex combinations of differential equations has been developed and demonstrated on a number of wide-ranging engineering problems involving heat and fluid flow. Professor Fitzgerald's group has made advances in transparent substrate visible LEDs, strained-Si MOSFETs, relaxed SiGe on SiO_2/Si, and Si-based optical interconnects. Materials science advances, specifically advances in defect control and interface control, have created these device-quality platforms for new microelectronics and optoelectronics. Professor Flemings continues research on semi-solid forming, with emphasis on seeking innovative ways to reduce cost and improve quality. Professor Gibson and her students are currently working on three research projects: on ultralight metal structures, on trabecular bone, and on cell-matrix interactions in porous scaffolds used in tissue engineering. Professor Hobbs' work on orthopedic joint prosthesis materials has provided ultrastructural information about the sequence of bone mineralization and apposition to ceramic coatings through *in vivo* and *in vitro* model studies and, through an additional industrial collaboration, about the development of oxide coating microstructures in oxidized zirconium knee prostheses. Professor Hosler continues her work on rubber processing technology and on the development of metallurgy in ancient Mesoamerica. Professor Latanision's group has developed a new approach for the quantification of underfilm corrosion of ferromagnetic materials that allows unambiguous corrosion rate determination beneath a polymer coating. Professor Lechtman continues a long-term research program on the development of bronze alloys in the Andean culture area in prehistory, including publication of a detailed article on the successful co-smelting of oxide and sulfarsenide ores of copper to produce arsenic-bronze ingots.

Professor Mayes' group has developed a strategy in which small fractions of amphiphilic comb polymer are added to the membrane casting solution in order to impart enhanced fouling resistance to poly(vinylidene fluoride) ultrafiltration membranes. Professor McGarry's group can now produce rigid silicone resins as tough as toughened epoxy resins. Dr. O'Handley and his students have completed a new system for measuring the magnetoelastic coupling coefficient in magnetic thin films on substrates, the results of which represent a major advance in the understanding and control of magnetic properties of materials. Professor Ortiz has completed setting up a state-of-the-art Polymer Mechanics Laboratory which has capabilities for mechanical testing of polymers at length scales ranging from individual macromolecules (*nanomechanics*), to thin films (*micromechanics*), to bulk materials (*macromechanics*).

Current research in Professor Powell's group includes cathode design for electrolysis with liquid electrolyte and product, and liquid free-surface shapes in materials processing. Professor Rose studied phase transitions in water and

continues his efforts on humanitarian demining research. Professor Ross' group has obtained new understanding of nanopatterned magnetic arrays, and of magnetic anisotropy in thin films for hard disks. Professor Roylance's research has centered on process-structure-property investigations of polymers and composite materials, dealing especially with mechanical properties.

Professor Rubner and his group continue development of a new class of solid-state red light emitters based on the Ru(II) complex and currently are achieving brightness levels five times that of a computer screen at voltages as low as 3 volts. Professor Russell is studying materials systems that are self-organizing under irradiation. In collaboration with several other DMSE faculty members, Professor Sadoway's group has continued to make advances in solid-state rechargeable lithium polymer batteries. Professor Scott's group is making rapid progress in understanding the phase inversion mechanism during compounding of immiscible polymer blends. Since joining the Department in August, Professor Smith has completely renovated and installed equipment in his lab, including a scanning probe microscope (SPM), a controlled atmosphere glove box for the SPM, various tube and muffle furnaces, and vacuum facilities needed for the growth of transition metal oxide single crystals. Professor Suresh's group has developed a variety of new theoretical and experimental methods for the analysis and measurement of mechanical and coupled properties of small-volume structures, thin films and active materials; several patents filed based on these discoveries are currently being pursued by industry for a variety of practical applications.

Professor Thomas' photonics effort with Dr. Yoel Fink on the "Omniguide" was mentioned as a "Breakthrough Runner Up for 1999" by *Science* magazine. Professor Thompson and his students developed and experimentally validated a complete set of models for process-sensitive and layout-dependent circuit-level interconnect reliability assessments. Dr. Trapaga studied viscosity and surface tension measurement in microgravity, and the mathematical modeling of electromagnetic levitation systems. Professor Tuller's group has been exploring lead perovskite systems as potential candidates for high strain actuators with large thermal stability and low hysteresis. Professor Vander Sande, in a collaboration with Professor Howard in the Department of Chemical Engineering, has been synthesizing fullerenes and fullerenic nanostructures in flames, using a process which allows them to develop an understanding of the nucleation, growth and transformation that occur amongst fullerenic species. Dr. Wada studies photorefractive crystals and photonic crystal integration for optical neural network. Professor Witt's group conducted solidification experiments involving BSO, under reduced gravity conditions, on board NASA's KC-135 facility; the results are to be used to optimize the design of a crystal growth research facility for the International Space Station. Professor Wuensch's group has determined the atomistic nature of chemically-driven disorder processes using neutron diffraction.

AWARDS AND HONORS

W. Craig Carter, Thomas Lord Associate Professor of Materials Science and Engineering, and colleagues from National Institute of Standards and Technology (NIST) were honored by Industry Week magazine with a 1999 "Technology of the Year" award for "Object-Oriented Finite Elements" (OOF), a public domain computer software. Using OOF, researchers can scan a micrograph and then use OOF's intuitive graphical interface to select specific subregions of the micrograph. Based on the geometry of these subregions, OOF allows users to develop a comprehensive analysis and prediction of how the material will respond to heat, stress, and other forces.

Professor Yet-Ming Chiang, Kyocera Professor of Ceramics, received the Richard M. Fulrath Award at the American Ceramic Society Meeting this April. The Fulrath Award recognizes outstanding academic and industrial ceramic engineers/scientists who are 45 years of age or younger. The award is also a symbol for the "Bridge Across the Pacific" program, through which U.S. recipients of the Fulrath Award spend part of a year in Japan. Professor Chiang was also awarded the New England Section of the American Ceramic Society's "F.H. Norton Award," in December 1999. This honor is named for Professor F.H. Norton, MIT Faculty 1927–61, who started the "Division of Ceramics" within what was then known as the Department of Metallurgy.

Yoel Fink, then a DMSE graduate student and now a new faculty member, was included in the November 1999 *Technology Review* list of 100 Top Young Innovators "who exemplify the spirit of innovation in science, technology, and the arts." He was singled out for his involvement in inventing a "perfect mirror" capable of reflecting light at any angle with virtually no loss of energy.

Professor Merton C. Flemings received the prestigious Tawara Gold Medal at a special ceremony organized by the Iron and Steel Institute of Japan in late March. This award is given to the researcher or engineer who has greatly contributed to the development of the iron and steel industry and technological research and development in the world. It is awarded once every five years to two individuals. Professor Flemings also received the National

Materials Advancement Award of the Federation of Materials Societies. The Award recognizes individuals who have demonstrated outstanding capabilities in advancing the effective and economic use of materials and the multi-disciplinary field of materials science and engineering generally, and who contribute to the application of the materials profession to national problems and policy.

During The Minerals, Metals and Materials Society (TMS) Annual Meeting in Nashville this past March, Professor Lionel C. Kimerling was formally presented with The Minerals, Metals and Materials Society Fellow award. Kimerling was elected "for his outstanding basic and applied research on defects in semiconductors, and for his professional and academic leadership in the field of electronic materials." Kimerling is the Director of MIT's Materials Processing Center, and the President of TMS Foundation which was established in 1993 "to develop and fund programs that will fully prepare future generations of professionals for leadership roles in the international minerals, metals, and materials community." He is also the Chairman of the Editorial Board of the Journal of Electronic Materials.

Dr. Harold Larson, DMSE Research Associate, has been honored by TMS for his co-authorship of the paper, "A Pilot-Scale Trial of an Improved Galvanic Deoxidation Process for Refining Molten Copper." Larson and co-authors P. Soral, U. Pal, and B. Schroeder received TMS's "2000 Extraction and Processing Technology Award."

At the annual Harvard-Smithsonian Meteorite Discussion Group Meeting and May Wine Festival, it was announced that Robert E. Ogilvie, Professor Emeritus, has a new namesake—minor planet 3973 is now named "Ogilvie." The citation reads, "Professor of Metallurgy at MIT and a researcher at the Boston Museum of Fine Arts, Robert E. Ogilvie (b. 1923) is known for his work in crystallography. Using homegrown woodruff, he also produces the essential ingredient for the annual May Wine Festival of the Harvard–Smithsonian Meteorite Discussion Group."

Dr. Robert C. O'Handley's *Modern Magnetic Materials: Principles and Applications* was published early in 2000 by John Wiley and Sons.

Professor Subra Suresh was elected TMS Fellow "for pioneering contributions to the understanding of mechanical behavior and mechanics of materials, and for leadership in materials education." Professor Suresh was also named the Clark B. Millikan Endowed Chair at California Institute of Technology in 1999–2000. Professor Suresh is the Coordinating and Principal Editor of the International Journal, *Acta* Materialia.

FACULTY NOTES

Faculty members of this department include these chairholders: Samuel M. Allen, POSCO Professor of Physical Metallurgy; W. Craig Carter, Thomas Lord Associate Professor of Materials Science and Engineering; Gerbrand Ceder, Union Minière Associate Professor of Materials Science and Engineering; Yet-Ming Chiang, Kyocera Professor of Ceramics; Michael J. Cima, Sumitomo Electric Industries Professor of Engineering; Merton C. Flemings, Toyota Professor of Materials Processing; Lorna Gibson, Matoula S. Salapatas Professor of Materials Science and Engineering; Lionel C. Kimerling, Thomas Lord Professor of Materials Science and Engineering; Christine Ortiz, John Chipman Career Development Assistant Professor; Adam C. Powell IV, Thomas B. King Assistant Professor of Materials Engineering; Caroline A. Ross, Lord Foundation of Massachusetts Assistant Professor of Materials Science and Engineering; Michael F. Rubner, TDK Professor of Materials Science and Engineering; Donald R. Sadoway, John F. Elliott Professor of Materials Chemistry; Richard L. Smith, AMAX Career Development Assistant Professor; Subra Suresh, R. P. Simmons Professor of Materials Science and Engineering; Edwin L. Thomas, Morris Cohen Professor of Materials Science and Engineering; Carl V. Thompson, Stavros Salapatas Professor of Materials Science and Engineering; John B. Vander Sande, Cecil and Ida Green Distinguished Professor; and August F. Witt, Ford Professor of Engineering.

Promotions were granted to five DMSE faculty members, effective July 1, 2000. Advancing from the rank of Associate to Full Professor are Professors Gerbrand Ceder, Eugene A. Fitzgerald, and Dorothy Hosler. Promotions from the rank of Assistant to Associate Professor were granted to Professors Caroline Ross and Chris Scott.

DMSE welcomed three new Assistant Professors to the faculty in Fall 1999. Christine Ortiz, was appointed John Chipman Assistant Professor. Ortiz completed her B.S. in M.S. and E. at Rensselaer Polytechnic Institute (1992), and both her Masters and Ph.D. at Cornell University (1997) with a doctoral dissertation entitled "Mechanical Properties of Liquid Crystalline Networks Based on Diglycidyl Ether of 4,4' –Dihydroxy-alpha-Methylstilbene+," supervised by Professors Edward J. Kramer, University of California at Santa Barbara and Christopher K. Ober, Cornell University. From August 1997 until joining the MIT faculty, she was a postdoctoral research associate with

Professor G. Hadziioannou at the University of Groningen in The Netherlands. There she developed a research proposal to the National Science Foundation to study the nanomechanical behavior of polymer chains using the atomic force microscope. This involved cutting edge experiments designed to develop the thermodynamic properties of individual polymer molecules.

Adam C. Powell IV joined DMSE as the Thomas B. King Assistant Professor. Powell received both a dual S.B. in Materials Science and Engineering and Economics (1992) and a Ph.D. (1997) from MIT. Professor Powell's doctoral dissertation, "Transport Phenomena in Electron Beam Melting and Evaporation," involved pilot plant-scale experimentation at Sandia National Laboratories, writing a finite–element solver for coupled fluid flow and heat transfer with melting front, and more specifically, packaging the model for industrial application, under the supervision of Professors Julian Szekely and Uday Pal. Following the receipt of his Ph.D. and up until joining the MIT faculty in August, he was a post-doctoral fellow at the National Institute of Standards and Technology. At NIST, Professor Powell was actively involved in the mathematical models of liquid free–surface shape and solidification, with application to soldered fiber–optic interconnect design, a new chip package in which underfill polymer is applied directly to the silicon wafer, and a device to test DNA solution for presence of multiple genes.

Richard L. Smith, appointed to the AMAX Assistant Professorship, earned his B.S. (1994), M.S. (1995) and Ph.D. (1998), from Carnegie Mellon University. His thesis, "The Structural Evolution of the MoO_3 (010) Surface during Reduction and Oxidation Reactions," used scanning tunneling microscopy (STM) and atomic force microscopy (AFM) to characterize the atomic scale structure of selected molybdenum and vanadium oxide surfaces, and to study the structural evaluation of the surface during gas phase reduction and oxidation reactions. Professor Smith completed a postdoctoral fellowship at CMU and the Alcoa Technical Center (1998), where he focused on several projects concerned with the synthesis of diaspore (α-AlOOH) and its subsequent transformation to corundum (α-Al_2O_3).

Two recent MIT graduates, Dr. Yoel Fink and Dr. Darrell J. Irvine, will be joining the DMSE faculty as Assistant Professors in the coming year.

STUDENT AWARDS

Outstanding Senior Thesis Awards went to Billie Wang of New Canaan, CT ("First Principles Study of the Magnetic Ground State and Thermodynamic Properties of Li_xMnO_2") and Michael Tarkanian of Brockton, MA ("3,500 Years Before Goodyear: Rubber Processing in Ancient Mesoamerica"). Paulina Kuo of Great Falls, VA won the Best 3B Internship Report Award ("Dynamic Tuning of Fiber Gratings with Thin Film Heaters"). Foundry Education Foundation Scholarships for Outstanding Students with an Interest in Metals Casting were presented to juniors Robin Ivester of Charleston, SC, and Nicole Zacharia of Hinsdale, IL. Juniors Melissa Light of Parkland, FL, and Albert Hung of Los Altos, CA, received Awards for Outstanding Service to the DMSE Community. Paulina Kuo was named Outstanding Student in the DMSE Class of 2000. Kuo was also awarded the TMS J. Keith Brimacombe Presidential Scholarship for 2000.

Dr. Raj Vaidyanathan, former DMSE graduate student and current post-doc in Professor Subra Suresh's lab, was awarded the 17th Louis Rosen Prize for his outstanding Ph.D. thesis from the Los Alamos Neutron Science Center at Los Alamos National Laboratory. The John Wulff Award for Excellence in Teaching went to graduate student Erin Lavik of McLean, VA. Eight DMSE students earned honors at the Third Annual BP Amoco/PPST Poster Competition held at MIT in April 2000. Axel Van de Walle won a Gold Medal Graduate Student Award from the Materials Research Society. New graduate students Lori Kensel, Ellen Siem, Cody Friesen, and Gary Maskaly were appointed Elsevier Distinguished Fellows for this year. This is the first year the department has awarded these Fellowships, funded by Elsevier Publishing. Andrew Kim received a Best Student Presentation Award from the TMS Electronic Materials Committee.

FUTURE PLANS

This year, the department has launched a DMSE Distinguished Lecturer Series to bring world leaders in materials science and technology to MIT. This Lecture Series, including six distinguished speakers, is intended to provide students and faculty with broad overviews of newly emerging topics in materials.

As the department sets out in exciting new directions in education and research, modernization of teaching and research laboratories is of the utmost importance. Plans are now underway for the renovation of more than 10,000 square feet of Department office and laboratory space in the main building. These renovation projects will result in state-of-the-art experimental facilities in the areas of biomaterials, nanomechanical technology, thin films, and

microphotonics; high-tech distance education classrooms capable of live, two-way interactions between the instructor and the student; a new graduate student lounge; and a new laboratory for computational materials science.

TRIBUTES

From June 28 to 30, a symposium in honor of Professor Merton C. Flemings was held at MIT. Over one hundred former students and current colleagues from around the world attended. Papers and posters were presented on many aspects of Professor Flemings' work, including dendritic solidification dynamics, control of casting quality, interdendritic fluid flow, semisolid processing, innovative materials processing, and materials science and engineering education. The Symposium's highlight was the banquet at the Museum of Fine Arts, Boston. Guests were privileged to hear a recital given by Yo-Yo Ma, the celebrated cellist, and to view the Museum's extraordinary collection of Asian art.

Dr. W. David Kingery passed away Friday June 30th at his home in Wickford, Rhode Island, at age 73. He was an MIT professor and long-time resident of the Boston area who became known as the "father of modern ceramics" for his role in providing a scientific foundation to the empirical practice used since ancient times to manufacture pottery, chinaware, tile, brick, cement, and glass. He received the S.B. in chemistry (1948) and Sc.D. in ceramics (1950) from MIT, and served on the MIT faculty in the Department of Materials Science and Engineering from 1951–88, where he was the first to hold the Kyocera Professorship. In 1988, he became Regent's Professor at the University of Arizona, Tucson. In the early 1950's, Kingery established MIT's first graduate education and research program in the science and technology of ceramics, and in 1960 wrote the first edition of a seminal textbook *Introduction to Ceramics*, now in print for 40 years and translated into the world's major languages. His scientific research led to the development of advanced materials with unique electrical, thermal, mechanical, and chemical properties that are today used in technologies such as automotive oxygen sensors, fuel cells, and a vast range of electronic components. In 1999, he was awarded the Kyoto Prize by The Inamori Foundation of Kyoto, Japan, for systematically integrating the knowledge and practice related to ceramic materials into a scientific discipline. In recent years, Dr. Kingery also analyzed from an archaeological standpoint the earthenware, pottery, and chinaware that are found throughout the world—studying the development and diffusion of ceramic techniques and providing cultural and anthropological interpretations of advanced technology. Amongst his recent books are *Japanese/American Technological Innovation* (W.D. Kingery, ed., Prentice Hall, Englewood Cliffs, NJ, 1991), *History from Things* (S. Lubar and W.D. Kingery, eds, The Smithsonian Press, Washington, D.C., 1993), *Physical Ceramics* (Y.-M. Chiang, D. Birnie III, and W. D. Kingery, John Wiley and Sons, NY, 1996) and *Learning from Things* (W. D. Kingery, ed., The Smithsonian Press, Washington, D.C., 1996). Dr. Kingery was also an avid sailor who co-organized the Marion-Bermuda Cruising Yacht Race. A memorial service for Professor Kingery will be held in the MIT Chapel on September 15, 2000.

More information about this department can be found on the World Wide Web at http://dmse.mit.edu/.

Subra Suresh

DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering has been working toward achieving these major objectives:

- Transformation of the discipline of mechanical engineering
- Strong undergraduate educational programs
- Contribution to the fundamental knowledge base and generation of technology innovation through research

We have assembled a staff of very talented and creative faculty, implemented strong educational programs, established organizational infrastructure and physical facilities that are suitable for cutting edge research, and generated strong external support for our research and education to achieve these goals. We have made significant progress toward achieving all of our objectives. The department is stronger than ever by any measure – second to none.

TRANSFORMATION OF THE DISCIPLINE OF MECHANICAL ENGINEERING

Several powerful forces have been changing the field of mechanical engineering.

- The development in information and communications technologies has changed the role of mechanical engineers in industry, academia, and business.
- The biological revolution has created new opportunities for understanding biological phenomena based on basic disciplines that underlie mechanical engineering. These opportunities led to the creation of instruments and other engineering tools for biotechnology and medicine.
- Mechanical engineers are dealing with micro- and nano-scale devices and elements in such industries as semiconductor manufacturing, biological and chemical applications, displays, etc.
- Engineering is increasingly dealing with large, distributed complex systems thanks to the Internet, the global economy, and transformation of industrial infrastructure. All of these changes require the ability to deal with large systems.

The Department of Mechanical Engineering has established the following as the objective to lead in the transformation of mechanical engineering discipline:

> *To transform the field of mechanical engineering from a discipline that has been primarily based on physics into one that is based on physics, information and biology.*

We have created the d'Arbeloff Laboratory for Information Systems, the Center for the Auto-ID Center, the Hatsopoulos Laboratory for Micro-Fluid Dynamics, and the Laboratory for Bio-Instrumentation, in addition to reinforcing the traditional areas of the department's strengths in engineering science, design, manufacturing, internal combustion engine, and systems to achieve this goal. New faculty members with appropriate educational and research expertise were hired from such disciplines as physics, computer science, electrical engineering, and chemical engineering, in addition to traditional mechanical engineering disciplines. As a result, the department has very strong faculty and programs.

EDUCATION

Undergraduate Program

The Department of Mechanical Engineering has about 400 undergraduate students—slightly smaller than five years ago. We have about 32% women students and 49% minority students[1].

The Department of Mechanical Engineering has embarked on a three pronged approach to improving undergraduate education: new curriculum structure, new instructional pedagogy, and the creation of modern teaching facilities. We have made much progress in all three areas.

The structure for our new undergraduate curriculum emphasizes four important elements of learning: the delivery of integrated knowledge of engineering disciplines, active learning, hands-on experience to gain a sense of engineering tasks, and the simultaneous teaching of analysis and synthesis in a single sequence of required subjects. It has four core sequences: mechanics and materials; thermal and fluid sciences; design and manufacturing; and dynamics, systems and control. The first class to graduate under the new curriculum did so in 1999. In addition to core

[1] All minority student percentage figures come from self-reporting students.

subjects, we have developed new elective subjects. For example, Professor Siu has created a sophomore level internet subject and Professor Lloyd has created a senior/graduate level subject in information and probabilities.

Fourteen Designated Professors are working in teams to develop core sequences in four areas. They are developing teaching materials--books, web-based materials, experiments and new teaching paradigms. These book writing efforts have been possible thanks to the "Pappalardo Curriculum Development Fund"—an endowment fund created by Neil and Jane Pappalardo. The books written by the Designated Professors will be published by the Oxford University Press under a new series—the *MIT-Pappalardo Series of Mechanical Engineering Books*. The Pappalardos share our dream of educating people worldwide better through the development of teaching materials.

The Committee on New Instructional Paradigms, under the leadership of Professor Mary Boyce, has developed a plan to introduce three new approaches to learning: "Scientific Discovery" mode of learning, "Socratic" modes of learning, and "Just in Time" of mode of learning. These ideas will be implemented under the MIT-wide initiative called the I-Campus Program.

With this curriculum in mind, we have modernized our educational facilities over the past several years. The Pappalardo Laboratories is the ideal setting for hands-on experience in design studio and machine shop for students. The AMP Laboratory also provides hands-on experience in the field of materials, and the d'Arbeloff Laboratory is the home for the study of mechatronics. The Der Torossian Computer Laboratory is where students learn their computational engineering, and the Cross CAD/CAM Laboratory will enable us to implement a "Just in Time" mode of learning.

In addition to these facilities, we are actively seeking funds to convert the Main Parking Lot into an atrium. The Committee on New Instructional Paradigms has proposed that we create cubicles for all our undergraduates around the edges of the atrium. This undergraduate space will enhance the reputation of MIT as a residential university by letting students learn from each other on a more interactive basis. We may have promising leads for the necessary funds, but do not have a firm commitment.

Although it is much too early to assess the relative quality of education they received, the new curriculum heightened the awareness of the importance of undergraduate education at MIT. In 1996, the department created the "Keenan Award for Teaching Innovation" to augment the "Den Hartog Award for Teaching Excellence". The recipients to date of the Keenan Award are Douglas Hart and Kevin Otto, Mary Boyce, and David Wallace. Five of mechanical engineering faculty members have been recognized by the Institute as the McVicar Faculty Fellows for their teaching excellence. The most recent recipients are Rohan Abeyaratne and Ernest Cravalho.

Graduate Education

Our graduate program is strong. According to statistics we have, we attract some of the best available graduate students in the country and the matriculation rate is higher than our sister institutions. External ratings support this contention. Our goal is to attract more of the best students in the available applicant pool to our department. The department has about 400 graduate students—17% of S.M. candidates are women and 7% of doctoral students are women. Minority students make up 13% of our graduate student body; foreign students make up 35%.

In 1999, we decided to reduce the number of graduate students we accept (from about 200 to 150 from an applicant pool of 650) and increase the yield by making the department more competitive through more fellowships—and by being more hospitable to those admitted. In 1999 and again in 2000, we had a special weekend orientation session for the best 50 students we accepted. Also with the support of the central administration, we increased the number of fellowships. As a result of all these actions, the number of financially guaranteed students who chose MIT increased to 73% in 1999 from 36% in 1998. We will continue to reduce the number of admitted students and attempt to increase the matriculation rate.

The number of new graduate subjects offered has increased with the addition of new faculty members and expansion of our research interests. At the same time, some of the subjects we used to offer have been eliminated to make room for new subjects. We offer new subjects in areas such as optics, manufacturing systems, design, the Internet, mechanics, information, and biophysics.

The department has been putting a large fraction of its resource into the support of its graduate programs. Since all professors teach only one subject a term, with the rest of their time being devoted to research and supervision of

graduate students, one might surmise that more than 50% of the faculty effort ultimately goes into the graduate program.

Our graduate program has undergone changes by addition of more subjects related to engineering systems, design, optics, bioengineering, and information. Recently, the faculty members in the d'Arbeloff Laboratory—under the leadership of Professor Harry Asada—have created a series of "Gateway" subjects. The goal is to enable our graduate students in mechanical engineering to take advanced graduate subjects offered in the Department of Electrical Engineering and Computer Science without taking all the pre-requisite subjects required for these EECS subjects. The creation of these new subjects has been made possible with the addition of new faculty members whose expertise lie in some of these fields and through the shifting research interest of our faculty members.

The department is one of the largest producers of Ph.D. level mechanical engineers in the country. One of the key steps in guaranteeing the quality of our doctoral graduates is the doctoral qualifying examination. An ad hoc faculty committee has been reviewing the doctoral examination—the goal, the process, the contents, and the results of the examination. We will introduce changes in the examination to reflect the diverse base of our research programs and faculty interests.

RESEARCH—EMPHASIS ON THE TWO ENDS OF THE RESEARCH SPECTRUM

Our basic research covers all areas of fundamental importance: solid and fluid mechanics, thermal science, control, design, materials, systems, and bioengineering. Our recent technology innovations have ranged from new manufacturing technologies, information based technologies, the Internet based technologies, quantum mechanical computers, bio-mechanical devices, bio-instruments, two-photon microscopy, software for design, new materials, ultra-fast and accurate PIV algorithms, wear resistant seals, new polymers and polymer processing techniques, new machine elements, and many others.

To facilitate research in these areas, we have created the d'Arbeloff Laboratory for Information Systems, Auto ID Center, Laboratory for Bio-Instrumentation, and the Hatsopoulos Laboratory for Micro-Fluid Dynamics. These new laboratories and centers have augmented and complemented other laboratories such as the Laboratory for Manufacturing and Productivity, the Sloan Automotive Laboratory, the Cryogenics Laboratory, the AMP Laboratory, the Center for Innovative Productive Development, and the Rohsenow Heat and Mass Transfer Laboratory.

On the basic research side, we have had a real burst of original research that has attracted worldwide interest. A few examples will be briefly given here. Associate Professor[2] L. Mahadevan, who is a leading academician in mechanics/applied mathematician/classical physics, has published many papers that explain many physical instability phenomena, (including folding of paper, buckling of liquid columns, and motion of falling cards), and biological phenomena (such as the motility of cells and the helical structure of DNA). His publications in Nature and Science have attracted even the interest of the popular press. The work done by Associate Professor Peter So on two-photon microscopy is letting us see the motion of molecules below the skin, which may someday enable us to deal with cancer cells non-invasively. The work on algorithms by Associate Professor Sunny Siu on the Next Generation Internet will not only increase the speed of the Internet but also affect manufacturing, inventory control, and many others. The fast and accurate PIV algorithm developed by Associate Professor Douglas Hart is affecting many fields in addition to fluid mechanics. Associate Professor Seth Lloyd and others in the department comprise one the leading groups in the country in dealing with the issue complexity and complex systems.

On the technology innovation side, our department has made major impacts in many different fields through major technological innovations that have been transferred to industry. Examples are: 3-D Printing by Professor Ely Sachs, DBM (Droplet Based Manufacturing) by Associate Professor Jung-Hoon Chun, Microcellular Plastics and Acclaro (software for designers of hardware, software, and others) by Professor Nam Suh, a PC-based controller by Professor Harry Asada, artificial skin by Professor Ioannis Yannas, Charge-Decay NDE and DOME by Associate Professor David Wallace, lithography stage by Associate Professor David Trumper, seals by Associate Professor Doug Hart, haptics innovation by Associate Professor Sanjay Sarma, and many others.

We also have many exciting research projects as a result of synergism between faculty members with different backgrounds. We have created the Auto ID Center, under the leadership of Associate Professor Sunny Siu and

[2] The rank is indicated here to illustrate the quality of the younger faculty members. Unfortunately, not all of our outstanding young faculty member's names can be listed here.

Assistant Professor Sanjay Sarma, with substantial financial backing from many major corporations to combine the Internet and the passive RF tags for the purpose of replacing and expanding the bar code technology. The standards and technologies that will be developed in this center may make a profound impact on even the "Just in Time" mode of learning. It is really heartening to see so much collaboration: between theoreticians and designers, between optics specialists and bioengineers, between manufacturing specialists and the networking specialists, and between specialists in quantum physicist and engineers. These teams create new technologies and theories involving students with the focus on their education.

Our expansion into information technology deserves a special mention. Five years ago, we decided to expand our activities in the information area because future mechanical engineers will not be able to practice their profession and become leaders unless they are deeply rooted in information technology. With the generous support of Mr. and Mrs. Alex d'Arbeloff we established the d'Arbeloff Laboratory for Information Systems. Many activities are taking place in the Laboratory, including the Auto-ID Center, Home Healthcare Automation Consortium, research on quantum mechanical computers, and others.

INTERDEPARTMENTAL AND INSTITUTIONAL PROGRAMS

Many faculty members are participating and taking a leadership role in the Singapore-MIT Alliance (SMA). This greatly benefits the department. For example, we are launching our "Master of Engineering In Manufacturing" Degree program, using the resource that has been made available by the SMA to the participating faculty members in the manufacturing part of the SMA. This one-year professional degree program will be available only to those with three or more industrial experience.

Two of our faculty members (Professors Roger Kamm and Ioannis Yannas) have taken up two-key appointment by taking up 1/2-time positions in the newly created Division of Bioengineering and Environmental Health.

SPACE

We have been fortunate to have major supporters for the department who made it possible to update, renovate, or create new facilities. The Pappalardo Laboratories continue to be used heavily by all undergraduate students taking 2.670, 2.007, 2.009, and other subjects. Its highly flexible and reconfigurable design makes it extremely versatile.

The d'Arbeloff Laboratory includes one mechatronics teaching laboratory that provide home our elective subjects, in addition to providing research facilities.

The AMP Laboratory continues to serve 2.002 students well.

The Der Torossian Computer Laboratory is always over-flowing with students taking many subjects that require computation. It will be an even more important resource as we try the "Just-in-Time" mode of learning.

Recently we have undertaken the construction of the Cross CAD/CAM Laboratory in Building 35, the home of the Laboratory for Manufacturing and Productivity (LMP), and the Cross Student Lounge in Building 3. These facilities have been possible with the generous gift of Mr. Ralph E. Cross, who has also given a senior chair and funds to support LMP.

We will be constructing the BJ and JH Park Lecture Halls in Building 3 to replace the old style classrooms 3-270 and 3-370 with a large classroom, a medium size classroom and two small classrooms, beginning in Summer 2000. These new lecture facilities will enable us to try two new modes of instructional paradigm: "Scientific Discovery" and "Socratic" modes of learning. Dr. Park is an alumnus of our department.

We are also preparing to renovate the second floor of Building 3 to create the Hatsopoulos Laboratory for Micro-Fluid Dynamics. It was made possible by the generous gift of Dr. George N. Hatsopoulos and Mrs. Daphane Hatsopoulos. They also established a senior chair in the department.

Like any expanding departments on campus, the Department of Mechanical Engineering needs more space. A few of our needs are listed here:

- Two years ago we submitted an ambitious fund raising plan for the Bio-Instrumentation Laboratory. We are hopeful that MIT will include it as one of its highest priority items of MIT's fund raising campaign.
- We also presented the idea that we should convert the Main Parking Lot into an atrium. It is our understanding that now this idea has been endorsed by all three architects that MIT has hired to work on its major projects.

Since then, our Committee on New Instructional Paradigm recommended that all undergraduate students be given their study space in the atrium so as to promote the student-student interactions, which is a key benefit of attending a residential university. We are working to find a benefactor.

- We need to expand into the space currently occupied by the Laboratory for Information and Decision Systems (LIDS) when they move into the new Stata Complex. This will alleviate the extreme space shortage faced by the department. We need space for the Manufacturing Institute, a new nanotechnology laboratory, in addition to the space for the Laboratory for Bio-Instrumentation Systems.

WOMEN AND MINORITY FACULTY MEMBERS

We have a poor record of finding and attracting women professors. It has been a difficult experience. At one point, we increased the number of women professors to four, but now we have only two women professors (one tenured and one not yet tenured) and one visiting professor. We have made special efforts, but the end result has been dismal. We will continue the effort.

We have done a little bit better in increasing under-represented minority professors. We found an extremely bright researcher and he is an outstanding teacher among our Ph.D. students. He has already taught our undergraduate students and received raving reviews. Marty Culpepper will be joining us as an Assistant Professor beginning in January 2001 after a short industrial tour to gain a perspective on industrial challenges.

CONCLUDING REMARKS

The Department of Mechanical Engineering has vigorous and innovative programs that befits an institution for creating future leaders.

It has a strong new undergraduate educational structure, outstanding facilities and new learning paradigms under development. Fourteen Designated Professors are creating new teaching materials and new teaching methods, which will be published in a special series of the Oxford University Press. This should benefit all educational institutions throughout the world.

The department has successfully initiated new research groups in information and Bio-Instrumentation, which augment the more traditional research groups in other areas. Furthermore, faculty members in these new research areas and in the more traditional areas are generating new research topics and paradigms, which show a promise of creating new knowledge base and leading to new technological innovations.

The department is attracting a large number of outstanding graduate students who thrive in its exciting research and educational environment. We are increasingly becoming more competitive through creation of new subjects and new research strengths at the crossroads of science and technology.

Through all of these efforts, the Department of Mechanical Engineering is approaching its goal of "Transforming the discipline of mechanical engineering from that which has been primarily based on physics to one that is based on physics, information, and biology."

More information on the department can be found on the World Wide Web at http://me.mit.edu/.

Nam P. Suh

DEPARTMENT OF NUCLEAR ENGINEERING

US News and World Report again rated the department number one in its field. The consistency of this ranking over many years has reflected the quality of scholarship by students and faculty in the department.

This past year has been one in which we have devoted much of our effort towards implementing our strategic plan. Our Visiting Committee reviewed our program this past fall and in general was pleased with the progress we have made in the implementation. They also agreed with our identification of those areas needing more effort and new ideas. We will send them an interim report describing further progress this coming fall.

Of particular interest, the Department of Nuclear Engineering and the MIT Energy Laboratory have jointly developed a new Center for Advanced Nuclear Energy Systems (CANES). The Center aims to create through research concepts for nuclear energy systems that promise more favorable economics, safety, proliferation resistance and environmental impact. The Center's programs involve development and application of methods for the design, operation, and regulation of current and advanced nuclear reactors and fuel cycles. This requires advances in knowledge about traditional scientific and technical disciplines, modern methods of systems reliability, probabilistic safety analysis and decision analysis, together with human interactions and management science. The Center will start operation in July 2000 with Professor Mujid S. Kazimi as its first Director.

UNDERGRADUATE PROGRAM

Twenty-five students were enrolled in the undergraduate program during the past year. This included 9 sophomores, 5 juniors, 11 seniors. Nine students completed requirements for the bachelor's degree in nuclear engineering.

We are nearing completion of a major review and updating of our undergraduate curriculum. All subjects have been re-examined in detail to insure that the correct basics are being covered, that overlap has been minimized, and that the curriculum meets the need of the wide variety of interests exhibited by our undergraduates.

Professor David Cory introduced a new undergraduate subject, 22.058 Principles of Imaging focusing on the principles of tomagraphic imaging. Applications include X-ray, PET, MRI, and ultrasound imaging. This subject is expected to be of wide interest throughout the Institute.

As part of our effort to increase NE's contribution to undergraduate education, two faculty members taught UG subjects outside the department (in addition to our "J" listed subjects): Professor Neil Todreas was involved in the teaching of 2.005 Thermal-Fluids Engineering I and Professor Jeffrey Freidberg in 6.002 Circuits and Electronics

GRADUATE PROGRAM

The graduate program totaled 113 students during the fall term. Of this number, 35 were enrolled for their first term. Forty-three percent are specializing in radiation science and technology; 36 percent are working in fission and energy studies, and 21 percent in fusion. The department awarded 13 masters, 1 engineers, and 7 doctoral degrees during the academic year.

Professor Larry Lidsky developed and taught a new course 22.591 Radioisotope Production and Applications. This course concentrates on radioactive isotopes but spends time on stable isotopes as well. This new course replaced his previous lab course, *Principles of Nuclear Radiation Measurement and Protection.*

Professor Sow-Hsin Chen and a graduate student Julian Lebenhaft introduced a new IAP course on "Quantum Mechanics For Nuclear Engineers" and taught it as an enrichment subject for needed undergraduate and graduate students. The course will be offered again next January.

FACULTY HONORS, AWARDS, AND ACTIVITIES

Professor Jacquelyn Yanch was named a Margaret MacVicar Faculty Fellow. This award recognizes MIT's outstanding teachers of undergraduate students and comes out of respect for both their intellect and their closeness to their students. This program honors the life and contributions of the late Margaret MacVicar who was Dean for Undergraduate Education. Professor Yanch also received the Ruth and Joel Spira Award for Distinguished Teaching. This award acknowledges the tradition of high quality engineering education at MIT.

Professor Ken Czerwinski received a Presidential Early Career Award for Science and Engineering in addition to a Department of Energy (DOE) Defense Programs Early Career Scientist and Engineer Award. The later award recognizes outstanding young scientists and engineers for their contributions to the Department's national security mission. Professor Czerwinski's work in developing the fundamental chemistry of the new element, rutherfordium (element 104), by perfecting "one-atom-at-a-time" chemical procedures on the highly radioactive atoms of ^{263}Rf is of significant importance to the Department's national security mission. He was also a visiting professor at the organic chemistry and nuclear science group at Conservatoire National des Arts et Métiers, Paris. He reviewed DOE-EMSP Proposals in Actinide Chemistry. He was a session organizer of the American Chemical Society session on nuclear waste forms. He is currently a member of the National Research Council Committee on Selecting Long Term Research Plan for the Deactivation and Decommissioning of Department of Energy Sites. In the 22.76 *Nuclear Chemical Engineering*, students performed plutonium-uranium separations with reactor irradiated materials.

Professor Mujid Kazimi was appointed in April as the first holder of the Tokyo Electric Power Company chair in nuclear engineering at MIT. He is Chairman of the MIT Research Reactor Safeguards Committee that reviewed during the fall the safety analysis of an upgraded power level that was part of the relicensing application of the MITR. He continues to chair the Hanford waste Tank Advisory Panel (TAP) for DOE-Richland that he has chaired since 1990. In November 1999, he gave an invited lecture at the annual meeting of the American Nuclear Society entitled "Rethinking Nuclear Energy Technology." In May he gave an invited lecture on the evolution of transmutation concepts at a symposium held at University of Nevada, Las Vegas. He organized 3-sessions on Liquid Metal Cooled Reactors at the ICONE-8 meeting in Baltimore that took place during April 2000.

Professor Jeffrey Freidberg was elected Chair of the Nuclear Engineering Department Heads Organization (NEDHO), a group whose role is to coordinate and develop national policies and positions with respect to the academic community's view of nuclear engineering education, following the American Nuclear Society's annual meeting in June, 2000. Professor Freidberg was also reelected to a 2-year term as a member of the DOE's Fusion Energy Science Advisory Committee (FESAC). This committee provides advice and guidance to DOE Director of the Office of Science, Dr. Mildred Dresselhaus on the national fusion program.

Professor Ian Hutchinson was appointed the Honorary Editor of "Plasma Physics and Controlled Fusion," one of the top journals in the field of plasma physics.

Professors Larry Lidsky and Michael Golay were elected fellows of the American Association for the Advancement of Sciences. Professor Golay continued his service on the Advisory Council of the Institute for Nuclear Power Operatons. He has served on the TOPS Committee of the DOE's Nuclear Energy Research Advisory Committee.

Professor George Apostolakis continues to serve on the International Nuclear Technology Commission that advises the governments of three German states (Baden-Wurttemburg, Bavaria, and Hesse) on nuclear technology matters. He has also served as vice-chairman of the Advisory Committee on Reactor Safeguards of the US Nuclear Regulatory Commission.

The PAI Outstanding Teaching Award (awarded by the student chapter of the American Nuclear Society) was presented to Professor Kim Molvig.

Professor Sow-Hsin Chen has been invited to chair a session on "Dynamics of water in confined geometry" at the Gordon Conference on Physics and Chemistry of Water, August 2000.

Professor Andrew Kadak served as the President of the American Nuclear Society for the 1999–2000 term.

RESEARCH

Fission

With the increasing concerns about global climate change, MIT's Department of Nuclear Engineering is taking a lead on developing advanced reactor technologies that can meet the technical, political and environmental needs of the future. The challenges facing new nuclear energy plants are economic, enhanced safety and non-proliferation with waste forms that are lower in quantity and more readily disposable. Through MIT's new initiative, so-called "Generation IV," advanced reactor designs are being promoted by the Department of Energy and supported by the Nuclear Energy Research Initiative (NERI). In the highly competitive race for new research grants the fission group

was part of the winning team in 6 out of 46 national grants the first year and 4 out of 10 the second year. The NERI program is just one piece of evidence suggesting a continuing resurgence of national interest in nuclear power as an option for the future. This work will lead to the development of advanced nuclear energy plants that can be competitive and safe to meet the energy and environmental challenges of the future.

The University Research Consortium (URC) of the DOE Idaho National Engineering and Environmental Laboratory (INEEL) has continued to support research projects at MIT, primarily in nuclear technologies, under the new contractor Bechtel which took over management of INEEL in October 1999. With support from the URC, a three-year program was initiated in October 1998 for development of advanced nuclear technology through an MIT/INEEL Strategic Nuclear Research Collaboration (SNRC). The aim of the SNRC is to investigate options that promote nuclear technology as a source of electricity in the next century. In its second year the program had a total funding at MIT of $1.2 million per year tied with about $1 million funding at INEEL. Four projects were funded under this initiative: the Modular Gas Cooled Reactor (MPBR) under the direction of Professors Andrew Kadak and Ronald Ballinger; the Lead-Bismuth Cooled Actinide Fueled Reactor (AFR) under the direction of Professors Todreas and Kazimi; advanced Fuels for Light Water Reactors under the direction of Professors Kazimi and Driscoll; and methodology of Performance-Based Regulation under the direction of Professors Apostolakis and Golay.

The new epithermal neutron irradiation facility based on the fission converter approach has started operation at the MITR. The preliminary measurements show that this facility is performing as expected based on the design calculations. The beam intensity is the highest available anywhere and there is negligible beam contamination from fast neutrons and gamma rays. When this beam is used for patient irradiations it will allow irradiations to be completed in a few minutes as opposed to several hours with the existing beam. Furthermore the therapeutic ratio will be doubled over the existing epithermal beam. These characteristics will greatly increase the probability of successful therapy with the neutron capture approach.

Professor Michael Golay is currently serving as Principal Investigator (PI) or Co-PI on six sponsored research projects. Within the USDOE's Nuclear Energy Research Initiative program he heads the MIT participation in three projects, which are also executed with ABB-Combustion Engineering (now Westinghouse Electric Co.), Duke Engineering and Services and Sandia National Laboratory. Each project is headed respectively by one of these organizations. In the order listed they are concerned with formulating and developing methods for implementation of a risk-informed safety regulatory approach for use with new reactor concepts, with optimizing and creating technologies for change management in the process for new nuclear power plant design, construction and testing, and with development and demonstration of a system for plant-wide health monitoring taking advantage of modern informatic technologies. These projects also respectively involve Professors Apostolakis, Hansen and Todreas.

Professors Apostolakis and Golay are jointly leading a new project, executed with the Tokyo Electric Power Company examining the implications of severe external events (using the example of earthquakes) involving nuclear power plants and the general public. The purpose is to formulate decision principles for deciding when to focus available resources upon the nuclear power plant and when to focus them upon investments to protect the public directly.

Professor Golay is PI on a USDOE-funded project developing methods for testing and quantifying the reliability of simple safety-related software. The motivation of this project is to bring nuclear power plant digital applications into the modern informatic era. Currently most nuclear power plants are about three generations of technology behind the rest of the world because of concerns among safety regulators that use of digital instrumentation and control technologies will introduce opportunities for new failure derived from errors in the associated software.

Professors Golay and Hansen are also working, with funds from the Kann-Rasmussen Foundation, to develop "leading" nuclear power plant performance indicators. Most performance indicators in use are "lagging" in the sense that they indicate past performance but provide little knowledge of likely future performance outcomes. Such lagging indicators have come into widespread use by the US Nuclear Regulatory Commission, in its efforts to make safety regulation more performance-based. In doing this the project team is working with nuclear power plants in the US and China trying to correlate their performance experiences and to use a computerized model of nuclear power plant performance to identify some useful indicators. The focus upon China is to try to help safety regulators in

developing a regulatory regime that is useful for regulating the operations of nuclear power plants, even when they are obtained from a diverse set of sources as is the case with China.

Professor Czerwinski was awarded a DOE NERI grant for investigating the speciation of neptunium in spent nuclear fuel. This project is in cooperation with Argonne National Laboratory. The project has initial results on neptunium interaction and speciation in the repository near field. Christi Sherman, a student supported through the project, is performing experiments at Argonne National Laboratory.

A joint project with Ecole Nationale Superieur de Chimie de Paris (ENSCP) and Conservatoire National des Arts et Métiers, Paris continues to investigate lanthanide and actinide separations. Ion specific resins have been investigated with Americium showing the ability to separate the target metal ions. The project on NMR imaging with Professor Cory is providing exciting results on resin behavior with metals and water. Three presentations at international conferences and two publications on the NMR imaging studies were completed. Dan Caputo, a student performing experiments in the project, will graduate with a Ph.D. in August 2000.

Through a URC project on Th fuel headed by Professor Kazimi, investigations on the behavior of Th fuel in a repository is continuing. Virginia Curran, the graduate student researcher on the project examined the solubility of thorium oxide and synthesized ceramics with thorium and uranium. Synchrotron studies with Lawrence Livermore National Laboratory have been made on the ceramics.

The project on the interaction of bacteria with uranium began with Professor Martin Polz of Civil and Environmental Engineering and provided the Masters thesis topic for Matt Lewis, who graduated in June 2000. The kinetics of bacteria reduction was determined. The use of indicator dyes for quick analysis of bacteria mediated reduction was evaluated.

With Professors Kazimi and Todreas a project on the release of radioactive polonium compounds from a hot lead-bismuth melt is investigated. The goal is exploring the feasibility of a direct contact heat transfer heavy liquid metal cooled fast reactor for actinide burning and power production. Particular emphasis is given to the study of the chemistry of polonium hydride, which plays a key role in the transport of the radioactive aerosols.

The development of effective soil washing techniques for the removal of actinides, primarily plutonium and americium, from contaminated soils is continuing. The overall goal of the research is to remediate sediments and concentrate waste for disposal. Currently, EDTA is being pursued as an extraction agent. Design aspects being explored include concentration, temperature, contact time, and synergistics.

Radiation Science And Technology

Professor Sow-Hsin Chen and his graduate student Ciya Liao have formulated a "Generalized Three Effective Eigenmode Theory" of supramolecular liquids and have applied the theory to analyses of a series of very high resolution inelastic x-ray scattering spectra from semi-oriented, fully hydrated DLPC Phospholipid bilayers they have measured at the European Synchrotron Radiation Facility at Grenoble, France last year. They succeeded in determining a complete frequency-wavevector dispersion relation for the in plane, propagating density waves for both the liquid crystalline and gel phases of the bilayer for the first time. The result has significant implication for a possible mechanism for transport of water molecules across the bilayer.

Professor Sow-Hsin Chen has proposed the idea and presented a scientific case for an Extended Q-Range Small Neutron Scattering Spectrometer to be constructed in the up-coming Spallation Neutron Source (an approved $1.3 billion new project to be completed in ORNL by 2005). The concept is approved by the SNS project and he is currently serving as a member of the Instrument Designing Team for its detailed design. He is also serving as a member of the Instrument Advisory Team of two new multi-million dollar Back Scattering Spectrometers being constructed at the SNS project and at LANSCE in Los Alamos National Lab., respectively.

Quantum Information Processing (QIP)

Professor Cory and his colleagues continue to make rapid advances in the theory, practice and implementation of quantum information processing. Working with Bruker Instruments, Inc. they have helped develop and taken delivery of the first special purpose commercial NMR designed for quantum information processing. They are now constructing a 2nd generation quantum processor which is designed to reach more than 10 qubits.

Professor Cory and his students continue to explore NMR approaches to quantum information processing through a set of collaborations with Dr. T. Havel (HMS), Professor S. Lloyd (Mechanical Engineering), Dr. R. Laflamme (LANL), Dr. E. Knill (LANL), Dr. J. Yepez (AFRL). Much of their recent efforts have been directed to making liquid state NMR implementations of quantum information processing robust at the level of 5 to 7 qubits.

They have also articulated two new schemes for extending the success of NMR approaches to QIP to larger systems and have started to build a solid state device capable of coherently controlling 10–30 qubits, which will have the unique feature of a resettable qubit. This is essential for exploring quantum error correction.

NMR of heterogeneous semi-solids

Professor Cory, in collaboration with Dr. S. Singer and Dr. Pabitra Sen of Schlumberger Doll Research Laboratory has continued to explore the structure and fluid dynamics of complex media. This is facilitated by a series of recently developed methods that permit the separation of the pore structure factor from the incoherent fluid motion. We have shown that the NMR signal (after suitable averaging and manipulation) provides a fingerprint of the sample geometry and that much of the inverse problem can be solved. Applications are expected in both biology and in granular or porous media.

Professor Jacqueline Yanch's new microbeam facility is nearing completion of its construction phase. This facility will have the capability of injecting a single proton or alpha particle into a particular portion of a living cell, thereby offering the opportunity, for the first time, of understanding from first principles the interaction of particle radiation with living matter.

NMR imaging of fluid transport through granular media

In collaborations with Professor Patricia Culligan (Civil and Environmental Engineering) and Professor Czerwinski the transport of lanthanides and the displacement of contaminants in model sands, soils and resins are being studied by NMR. For resorcinol resins (used to trap metals) the NMR results provide a clean and unambiguous measure of bound, plasticizer and free water including their exchange properties.

Atomistic simulations

Professor Sidney Yip is continuing his participation in developing the interdisciplinary area of simulation research in materials science. He was an organizer of an international symposium on multiscale materials modeling in Beijing, China, June 1999 with the proceedings published in the Journal of Computer-Aided Materials Design, of which he is the Principal Editor. In January this year he visited the Hong Kong Polytechnic University under a fellowship from the Royal Society (UK) where he initiated a short course on materials processing simulations from the atomistic to the continuum .

Fusion

Under the direction of Professor Ian Hutchinson, the Alcator C-Mod tokamak continued its studies in high-performance, compact magnetic plasma confinement. Approval was obtained in March 2000 to proceed with the upgrade consisting of installing 3MW of Lower Hybrid power. This addition will permit quasi-steady-state exploration of Advanced Tokamak operation with high fractions of self-generated current. The construction phase, led by Professor Ronald Parker, should be completed after about 30 months. In the subsequent plasma operations we will attempt to demonstrate the feasibility of steady-state tokamak operation attractive for future reactor application.

The diagnostic neutral beam installed as a collaboration with the University of Texas is now operational and the diagnostics based on it have begun to be commissioned. These challenging experimental measurements provide far more detailed information about the profiles of temperature, flow velocity and current density.

Experiments have now established that the core rotation observed on Alcator C-Mod arises in the absence of radio frequency wave heating and recent measurements ruled out an RF mechanism of a type theoretically predicted even when RF is applied. In other words, the plasma spontaneously spins itself up as a result of momentum transport. The process by which this occurs is not understood but may prove to be a key link to understanding tokamak anomalous transport and its suppression.

The dynamic baffles controlling the divertor neutral gas flow during plasma operation have led to new understanding of the determining factors for particle recycling. Recycling impurities are strongly influenced by the divertor flow but the main-chamber neutral pressure is relatively unaffected because the divertor pressure adjusts itself dynamically to maintain approximately constant throughput.

The new antenna for RF heating, installed as part of a collaboration with Princeton Plasma Physics Laboratory, has been upgraded to improve its heating efficiency and higher total heating power levels are being obtained to achieve higher pressure, probing MHD limits.

The high-resolution measurements of the sharp edge of the plasma are showing remarkable structure in the transport barrier, and indicate that additional physics beyond ideal magnetohydrodynamics is essential to explain its stability. Under some circumstances on Alcator C-Mod the particle confinement of this edge transport barrier is reduced, allowing the density and impurities to be controlled. A specific instability has now been measured that appears to be responsible for this favorable mode of operation. Work continues to identify the instability and understand the conditions for its appearance.

Professor Freidberg and graduate student Antonio Bruno have been developing a new theory to predict the anomalos heat transport coefficient in Reversed Field Pinch Configurations. The basic idea is to calculate steady state profiles assuming the plasma has relaxed to a lowest energy state consistent with being marginally stable to tearing modes, the instabilities suspected of being responsible for the anomalous behavior. He is also working with graduate student Mike Thomas on developing a new linear MHD stability code capable of high accuracy including the effects of toroidal plasma flow and a resistive wall surrounding the plasma.

STUDENT AWARDS AND ACTIVITIES

Extracurricular NED student functions centered on the MIT American Nuclear Society Student Branch. There have been many social and athletic events during the year, reflecting the interests of its members. The every other Monday Afternoon Seminar Series, NED Orientation for incoming students, holiday party, and international dinner are a few of the successful events from the past year.

The MIT Chapter of the Alpha Nu Sigma Society, a national honor society for students in applied nuclear science and nuclear engineering, recognized 6 graduate students and 2 undergraduate students for their outstanding academic achievement. The MIT Health Physics Society Student Branch's activities are focused on environmental radiation transport, radiobiology, and radiation detection and measurement.

The paper "Void Fraction Prediction for the Pb-Bi/Water Direct Contact Nuclear Reactor" authored by Jacopo Buonjiorno, Neil Todreas and Mujid Kazimi was one of three best papers selected from the thermal hydraulic track at the recent ASME sponsored 8th International Conference on Nuclear Engineering (ICONE-8) held April 2–6, 2000 in Baltimore, Maryland. There were a total of 750 papers presented at the conference.

Graduate student Ju Li presented a talk at the international symposium on multiscale materials modeling in Beijing, China, June 1999 which won a best paper award from the sponsoring organization, the International Union of Materials Research Society.

A number of students were recognized at the annual international dinner/awards ceremony in May 2000:

Amanda Johnsen received the Roy Axford Award for academic achievement by a senior in nuclear engineering.

Winnie Yong received the Irving Kaplan Award, which recognizes academic achievement by a junior in nuclear engineering.

Jacopo Buongiorno in recognition of his excellence in academic performance and professional promise received the Manson Benedict Fellowship.

Dan Caputo, Randi Cohen, Julian Levenhaft and Richard Weil shared the Outstanding Student Service Award in recognition of exceptional services to the students, the department and the entire MIT community.

Li Lu received the Outstanding TA Award in recognition of exceptional services to education by a teaching assistant.

Three students from the actinide research group, Virginia Curran, Karen Noyes, and Christi Sherman, received American Nuclear Society Fellowships.

The Scholarship Subcommittee of the ANS Education and Training Division selected Christopher Melhus for the 2000 ANS Everett P. Blizard Scholarship and the Health Physics Society and Landauer Incorporated selected him as the 2000–2001 Robert S. Landauer Sr. Memorial Fellow.

More information about this department can be found on the World Wide Web at http://web.mit.edu/ned/www/.

Jeffrey P. Freidberg

DEPARTMENT OF OCEAN ENGINEERING

The mission of the Department of Ocean Engineering is to educate and prepare students to assume leadership positions in industry, government and educational institutions, and to influence future directions of ocean engineering education and practice; to develop and disseminate the knowledge and technology to foster and enable the wise and effective use, development, and preservation of the ocean, its natural resources and environment.

MAJOR ACCOMPLISHMENTS

Academic Year 1999–00 continued to be an exciting year for the Department of Ocean Engineering. The Ocean Engineering Teaching Laboratory once again hosted the "Discover Ocean Engineering" Program, a four-day event specifically designed to introduce incoming freshmen to student life at the Institute. This event was extremely successful in the fact that it was enjoyed not only by the students but at the same time very well received by parents and the MIT Administration. Professor Henrik Schmidt continues to serve as Chief Scientist for a major joint research program conducted in the Mediterranean Sea titled "Generic Ocean Array Technology Sonar" (GOATS). It involves the use of multi-static active acoustics to detect and classify buried objects in the seabed. GOATS is a potential system for measurement of 3-D multi-static acoustic fields that can provide platforms for multi-static sonar concepts. A significant follow-on experiment is scheduled for September–October, 2000. This set of experiments focuses on shallow water technology and is sponsored by NATO. The design and development of the *Robo Tuna* by Professor Michael Triantafyllou and his colleagues continues to be a major activity in the department. The research in this area enables researchers to gather data about how a robotic fish should be controlled in order to swim efficiently, and to deepen the understanding of the hydrodynamics of swimming fish. *Robo Tuna* also continues to be a major source of Undergraduate Research Projects attracting students from various departments to the Testing Tank.

UNDERGRADUATE EDUCATION

The philosophy of undergraduate education in Ocean Engineering is:

- an education firmly based on the fundamentals of engineering science
- broad exposure to the fundamental disciplines of Ocean Engineering
- in-depth concentration in one Ocean Engineering sub-discipline
- participation in undergraduate research opportunities (UROP) and undergraduate professional opportunities
- capstone Ocean Engineering systems design experience
- emphasis on teamwork, communication, and project management skills essential for professional practice in Ocean Engineering

The specific required and elective subjects offered to support this philosophy continue to be extensively reviewed by the faculty at various retreats and faculty meetings. Senior management in the industries that hire our graduates continue to be visited to evaluate the curriculum. These industries include the traditional shipbuilding and oil companies as well as other marine-related companies. The curriculum is sound, requiring only minimal adjustment to reflect evolving technology and future industry needs.

In the Fall of 1999, seven sophomores entered the department bringing the total undergraduate enrollment to 17. There are only a few universities that offer educational programs in Ocean Engineering (and Naval Architecture and Marine Engineering). Even fewer offer doctoral programs. Maintaining a sufficient level to technically lead design initiatives into the next century is of some concern to the industry and more significantly to the Navy. It is the strong view of industry and government technical leaders that the ship designers for the future should be educated by leading researchers and educators in the field.

The department faculty continues to review this situation. There is a strong, unanimous consensus that despite the low enrollment, the undergraduate curriculum should be continued. It provides an intellectually stimulating connection to the undergraduate student body and an opportunity to teach at the undergraduate level. The faculty continues to be freshmen advisors and to offer freshman seminars.

While we intend to continue our efforts to attract students to the field, the faculty continued to pursue opportunities to contribute beyond the department. Relationships with Chemical Engineering have been established to share responsibility for teaching numerical analysis and software engineering. *Numerical Analysis* 13.002J (10.002J), is offered jointly with Chemical Engineering and taught by OE faculty and *Introduction to Computer Methods*, 10.001 is taught by Chemical Engineering faculty. The first year of this undertaking went very well and we intend to continue this collaboration. At present we are experimenting with a structural design subject, *Computational*

Techniques for Structural Design, 13.019. A central feature of the subject is structural design using comprehensive computer tools to permit real life designs. We plan to collaborate with Civil Engineering and we are investigating what it will take to also interest Mechanical Engineering. We intend to aggressively seek other similar sharing relationships.

The MIT Museum and the Hart Nautical Collections combined to create a display in the Building 5 Hart Nautical Gallery to create awareness of the challenging and exciting activities in the oceans. The display, formally commissioned in conjunction with the department's visiting committee meeting in March, 1999, continues to display a number of department activities. The department's Undergraduate Teaching Laboratory, showing recent undergraduate design projects, remains featured.

For the second year, a new innovative program for incoming freshman, *Discover Ocean Engineering: A special Introduction to MIT*, was offered to the Class of 2003. This program was set up in 1998 as a four-day program for incoming freshmen and designed to provide a first glimpse of what engineering is all about. It also allows the students to sample some of the opportunities that the field of ocean engineering has to offer and gives them a jump on becoming involved in campus life and building close relationships between the students, our faculty and staff. The agenda included hands-on experience building a small remotely operated vehicle (ROV), testing it in the water, and providing a chance to perform some actual research experiments with an ROV in Boston Harbor. There are approximately 30 incoming freshmen of the Class of 2004 who will attend the summer experience of Discover Ocean Engineering this year. This program remains one of the most subscribed to each summer.

GRADUATE EDUCATION

Graduate education remains strong in the department and our graduates are highly sought by industry. The graduate enrollment for 1999–2000 was 107. Within our department the graduate programs offer a spectrum of research and educational opportunities that provide the specialization needed to become leaders in and shapers of the marine field in our global society. The education is highly specialized and requires a deep understanding of the technology involved.

Our graduate subjects complement the research performed in the department very well. The graduate programs are focused on three major areas: Naval Construction and Engineering; Engineering Science applied to problems in the ocean; and Ocean Systems, with emphasis on business and management.

A significant element of the department's education program is the Naval Construction and Engineering Program. This long-standing program is nearing the 100th anniversary of initiation and is designed for students interested in a career as a professional naval engineer. Ships are one of the most complicated technical systems produced and continue to push the state of the art. In addition to concentrating on hydrodynamics, acoustics, structures, and design, the curriculum provides an appreciation for total ship engineering in a manner not covered by specialists in mechanical, electrical, structural, or nuclear engineering.

The next major element of our graduate education is the segment that specializes in engineering science applied to problems in the ocean. Our curriculum focuses on four areas: acoustics, hydrodynamics, structures and structural dynamics, and design and marine robotics.

The acoustics program prepares the next generation of oceanographic engineers. It is a major element of the joint program with Woods Hole Oceanographic Institution. It covers all aspects: theoretical, numerical and experimental with particular strengths in acoustical oceanography and signal processing.

Our hydrodynamics group has a rich tradition and history, having made and continuing to make some of the most significant contributions in the field. We offer a rich program in theory and computational hydrodynamics preparing our graduates for positions of leadership spearheading major innovations in the offshore industry.
The structures and structural acoustics curriculum exposes our students to all the fundamentals needed to prepare them for a successful career in marine structural mechanics. Our areas of excellence include plasticity, crashworthiness, structural response of complex structures, forming of doubly curved plates, and cable dynamics.

Our last area of engineering science is design and marine robotics. The graduate curriculum in this area is dominated by the basic subjects for our naval construction program but a number of basic and advanced subjects in offshore design, control theory, computational geometry and underwater navigation are also offered.

The program in Ocean Systems Management is intended for students with solid engineering backgrounds who are interested in the business and government management aspects of ocean engineering systems and activities, including ocean transportation, marine resource development, environmental management, public policy and ocean use, ocean mining, ports, and fisheries. Students who pursue this curriculum have a solid background in engineering and are looking to broaden their ability to include knowledge of economics, business practices and management. Some of our alumni are among the better known ship owners and this area offers significant potential for growth.

RESEARCH ACTIVITIES

The department's faculty and staff continued in their pursuit of a variety of outstanding research programs. Many of these are currently receiving worldwide attention both inside and outside the field of ocean engineering.

Professors Arthur Baggeroer and Henrik Schmidt have completed a joint effort project for NSF and the New England Aquarium called "Sounds in the Sea" which developed an exhibit highlighting the role of sound in the ocean portraying natural sounds such as whales, fish and volcanoes as well as man-made sounds. This exhibit opened at the New England Aquarium in April and runs through November 2000 before traveling to other aquaria. From the feedback received, it has been an extremely popular exhibit with some of the equipment wearing out through over use. In addition, they continue with their research in broadband active and passive matched field processing in shallow water, an area in which both Professors Schmidt and Baggeroer are acknowledged as two of the pioneers.

Professor John Leonard's primary research focus is the development of new robust algorithms for concurrent mapping and localization (CML) in large-scale environments. The goal of CML is to enable an autonomous underwater vehicle (AUV) to build a map of an unknown environment while simultaneously using that map for navigation. This year he made a major advance over the state-of-the-art in CML, with the development of decoupled stochastic mapping (DSM), a new, computationally efficient approach to the map scaling problem.

Professor Nicholas Makris continues both his experimental and theoretical work in remotely sensing the marine environment with underwater sound. This includes determination of oceanographic properties of the water column, geophysical characteristics of the sea floor, and the localization, imaging and classification of submerged objects.

Professor Henry Marcus continues with his work on Automatic Identification Technology (AIT) which is sponsored by the New Industry Research Organization (NIRO) of Japan and focuses on improving the movement of marine containers in international commerce. Any function where manual identification, record keeping and paper processing can be replaced by AIT is a potential area of cost savings. Building on the knowledge gained from the NIRO project in identification technologies, Professor Marcus continues working with the Navy's CVNX (new aircraft carrier program) to try to improve materials and personnel management aboard a new aircraft carrier using radio frequency identification (RFID) tags.

Professor Koichi Masubuchi, although officially retired, remains active in activities related to NIRO. Kawasaki Heavy Industries (KHI), the designated lead company for NIRO, is interested in having MIT work with NIRO and Professor Masubuchi is involved in the operation of a project begun in 1997 at the MIT Sea Grant College Program. This project was continued by a new grant from NIRO in July 1998 and again in 1999. In addition, a two-year project entitled "Advancement of Manufacturing Technologies Through Applications of Laser Measurement and Fabrication Techniques" was initiated in July 1998, under the supervision of Professors Masubuchi, Nicholas Patrikalakis, and Dr. Takashi Maekawa.

Professor Jerome Milgram continued with his research on "Computational Reconstruction of Optical Fields from Holograms" where the emphasis is on computational modeling, code development and numerical testing. The first two technical utilizations will be for three-dimensional particle image velocimetry for complete measurement of flow fields, and for studying the interaction of marine microorganisms, largely plankton, with their fluid environment.

Increased collaboration among the OE faculty is taking place in the Marine Robotics Laboratory. During the past year the lab was made available for another class of activities related to underwater acoustics. In addition, the space is shared with students of Professors Dick Yue and John Leonard. Professor Milgram has begun setting up apparatus for making holograms, particularly the kind of holograms needed for Holographic Three-Dimensional Particle Image Velocimetry.

Professor Nicholas Patrikalakis is currently involved in coastal safety and coastal zone management issues besides contributing to the solution of outstanding design and manufacturing problems and educating future leaders in the area of non-linear computational geometry and CAD/CAM. In his project, "Model for Ship Transit Risk," his goal has been to develop a statistical model for evaluating the relative risk of ship transit through the nation's ports and waterways. In his "Poseidon: A Coastal Zone Management System in the WWW", he deals with the creation of a distributed information system for coastal zone management using internet technologies.

Professor Henrik Schmidt's research in multi-static active acoustics has replaced the Arctic acoustics as the main ONR core funded research. He is developing new numerical models of the 3-D scattering by objects, such as mines and hazardous waste containers, on and below the seabed in shallow water, and the associated scattering and reverberation from the seabed itself. Funding for this project covers the fundamental physics and modeling effort, and the analysis of the Generic Ocean Array Technology Sonar (GOATS) experiments. GOATS is a potential system for measurement of 3-D multi-static acoustic fields that can provide platforms for multi-static sonar concepts. A proposal by Professor Schmidt for a five-year official Joint Research Program (JRP) with SACLANT Undersea Research Centre in Italy towards the development of the GOATS concept for mine countermeasures, has been accepted, and the first joint experiment scheduled for September–October, 2000. This set of experiments focuses on shallow water technology and is sponsored by NATO.

Professors Baggeroer and Makris continued in the positions of SECNAV/CNO Chair and Scholar, respectively, a four year program which began in October 1998.

Along with Professor Baggeroer, Professor Schmidt is involved in the use of acoustics to monitor the long-term development of the ocean temperature to possibly reveal a trend towards global warming. This work is done in collaboration with researchers at Scripps and other institutions, and focuses on the Pacific Ocean.

Professor Schmidt is additionally involved in the development of new multi-disciplinary, multi-scale coastal observation and prediction systems known as Littoral Ocean Observations and Prediction Systems (LOOPS). As one of the PI's in the Harvard-led LOOPS NOPP (National Oceanographic Partnership Program), Professor Schmidt has been responsible for the acoustic sensing component. Along with Alan Robinson (Harvard) and Professor Patrikalakis (Co-PI), he has played a major role in laying out the overall concept and architecture for an entirely new generation of forecasting capability, with the Poseidon distributed computational framework providing the infrastructure for sensors, platforms and modeling resources.

Professor Michael Triantafyllou continued with his work on the development of biomimetic fish-like robots under the sponsorship of ONR and DARPA, in cooperation with Draper Laboratory, IS Robotics and Electric Boat. He also remains involved with vortex induced vibrations of marine structures (cables and risers) sponsored by ONR and a consortium of oil companies.

Professor Triantafyllou continued with the second phase in the development of a rapidly maneuvering flexible-hull vehicle. This is the continuation of a previous phase which was undertaken with IS Robotics. The "RoboMuskie", presently under construction is being developed as an industrial-strength, fast-maneuvering vehicle. A new effort entitled "Biomimetic Flapping Foil for Propulsion and Maneuvering", will address theoretically and experimentally basic research issues involved in the fluid mechanics, sensing and control, and actuation of a three-dimensional unsteadily flapping foil employing vorticity control to enhance the underwater agility of rigid-hull marine vehicles. The results of the study will form a basis for the near term development of technology to augment and enhance the capability of existing vehicles. It is envisioned that the flapping foil will be a self-contained thruster device, which can be used to provide the necessary control forces to submersibles and surface ships in rapid maneuvering.

Professor Tomasz Wierzbicki's "Ultralight" project which involves strength, ductility, and fracture of welds with defects remained the focal point of his research this past year. The arrival of the 200 kN stroke MTS testing machine which was installed in the Impact and Crashworthiness Laboratory last September, is used daily for a number of projects carried out with regard to the Ultralight project. His Tanker Safety project was completed with the final year being devoted to the development of the collision module of the computer program DAMAGE.

Professor Dick Yue continued on a number of long-term research efforts as well as in several new areas of coastal wave dynamics and three-dimensional wave coherence, both of which are relevant to coastal operations. His main research interests lie in the areas of theoretical and computational marine hydrodynamics and applied mechanics.

EDUCATIONAL INITIATIVES

In the summer of 1999, Professor Henry Marcus was again part of the MIT/Marsoft team teaching a new seminar in Risk Management in Shipping Investment. This seminar was very successful and will be taught again during the summer of 2000. Professor Marcus also developed a new freshman seminar, *The Wonders of Ocean Transportation.* Two of his established subjects, *Management of Marine Systems* and *International Shipping* are undergoing minor modifications with new case studies being written to improve the teaching materials.

Development of the new subject 13.024 , *Numerical Marine Hydrodynamics*, by Professor Milgram was mainly done in the summer of 1999. This resulted in a set of extensive class notes covering the material presented in the classroom in the Fall of 1999.

Professor Nicholas Patrikalakis, with the assistance of Dr. Takashi Maekawa, has completed his revision and update of the notes for 13.472J, *Computational Geometry*, a joint program in Civil and Environmental Engineering, Mechanical Engineering, and Aeronautics and Astronautics. These notes in a new, more comprehensive printed version, form the basis of the new textbook, which has been completed and will be used in the classroom for the first time next spring. This book will impact the educational initiatives of numerous academics around the world as well as eight MIT professors whose research is related to CAD and computer graphics.

Professor Dick Yue is a participant in a proposal entitled "A School-Wide Modular Program for Fluid Dynamics," submitted by C. C. Mei, and selected by the Project I-Campus, a collaborative initiative of MIT and Microsoft Research to conduct research and create new technologies that will set the pace for university education in the next five to ten years. The department is providing support to the project by funding a full teaching assistant for one term.

Together with Professor Wierzbicki and Dr. Burke, Professor Patrikalakis initiated extensive discussions concerning revision of our entire graduate and undergraduate mechanics, structures, materials and fabrication curriculum (including considerable exchanges with Courses 1, 2, 3, and 16 faculty), a process which is still underway in concert with the Undergraduate Committee deliberations.

Our faculty retreat held in December 1999 included an evaluation of our degree requirement, a summary of the objectives of each subject and of opportunities for changes and improvements in our subjects. Several ideas for improvement were proposed.

The doctoral review committee, chaired by Professor Paul Sclavounos, proposed revisions to our Part I Doctoral Exam format which will become effective in FY2001.

A new, 6-unit undergraduate subject, 13.002J, *Introduction to Numerical Analysis for Engineers*, was taught jointly with Chemical Engineering, as a follow-up to 10.001. This new subject, offered this past spring, is unique at the Institute in terms of providing introduction to numerical analysis and was well received by students.

The acoustics group initiated a reorganization of our curriculum taught jointly with Woods Hole staff. There will be a major restructuring resulting in two key subjects. The first one will merge the material of 13.851 and part of 13.861 into one comprehensive new introductory subject. This will be followed by a new subject in the area of computational and seismo-acoustics which incorporates the remainder of 13.861 and will be offered in the Spring.

Professor Triantafyllou prepared a new term project for 13.49 to simulate the engine-propeller-hull system during maneuvering on ATHENA. In addition, he prepared a laboratory to simulate maneuvering on model scale vehicles. The Testing Tank facility has undergone renovation and expansion which will aid tremendously in both education and research. Three major labs for 13.42 are done here every spring while 13.021 has one major lab every fall. In addition, 13.017 and 13.018 both use the Tank for testing.

Professor Vandiver began a three-year term as the Dean for Undergraduate Research on July 1, 1999. This includes continuing as the Director of UROP and the Director of the Edgerton Center and working closely with the Dean for Students and Undergraduate Education to advance initiatives in undergraduate education.

Redesign of the 13.412 curriculum, integrating computational design into the lecture content, was completed and implemented in the Fall 1999. This included coordination of classroom and computer lab lecture with simultaneous hands-on training to education the students on design impact. The lecture lessons were applied directly to the tools

so the student could see the design change to reinforce learning. The integration of computer tools for the 13.412 and 13.405 continues, with the incorporation of a product data model and CAD tool expected for 2000.

The 13A Ship Computational Design Lab was expanded to 10 workstations in 1999. It is planned to expand the lab to 16 workstations, each with room for lecture materials and drawing laying outs during the upcoming fiscal year. The lectures will be performed at the workstations using networked connections and digital projection in the lab. This will be used to teach the students the updated curriculum, as well as provide an integrated design review location for 13.412, 13.413, and 13.414 student projects.

DEPARTMENTAL AWARDS AND ACTIVITIES

Professors Arthur B. Baggeroer and Nicholas C. Makris continued their second year in the positions of SECNAV/CNO Chair and Scholar, respectively. Each award includes four years of support for one Research Chair and associated Scholar.

Dr. David Burke, Senior Lecturer, taught 13.122, "Ship Structural Analysis and Design." Along with Professor Chryssostomidis, he has been evaluating the Navy's need for future basic research in the field of Naval Architecture.

Professor Chryssostomos Chryssostomidis continued his involvement in the department's design lab activities. His sabbatical for Spring Term 2000 provided the opportunity to develop some long-range ideas such as how to best harness information technology in the development and dissemination of scientific information, create new opportunities and partnerships in Naval Architecture education and research, and determine the role of the Department in the modernization of our industry and many others. It is expected that developing these ideas will help the department continue renewing itself.

Professors Justin E. Kerwin and Koichi Masubuchi, although retired, continued with 49% appointments and remain active in teaching, student supervision, and research.

Professor Justin Kerwin was one of three MIT faculty members and 11 alumni elected to the National Academy of Engineering, one of the highest professional distinctions accorded an engineer.

Professors John Leonard and Nicholas Makris were promoted to Associate Professor without Tenure effective July 1, 2000.

Professor Nicholas Makris was awarded the 2000 Doherty Professorship in Ocean Utilization from the MIT Sea Grant College Program. He and Professor Kerry Emanuel of Earth, Atmospheric and Planetary Sciences, were chosen as one of four Edgerly Science Partnership Fund Awards with their project "Tropical Cyclone Mitigation."

Professor Henrik Schmidt served as Acting Department Head during Spring Term 2000.

Professor Michael Triantafyllou appeared on a segment of PBS's "Scientific American Frontiers" hosted by Alan Alda in a program called "Natural Born Robots" talking about the development of a robotic pike at the MIT Testing Tank.

Professor Dick Yue was named Associate Dean of the School of Engineering.

Student Awards

Benjamin Connell, Yile Li, Craig Martin, and Joshua Wilson were recipients of the MIT Presidential Graduate Fellowships for FY2000.

Katherine Croff received the Society of Naval Architects and Marine Engineers (SNAME) Undergraduate fellowship award for FY2000.

Katherine Croff, and Whitney Conforth were the winners of the SNAME Undergraduate Honor Prize for Student Paper, NE Section Meeting of SNAME, in January 2000.

Purnima Ratilal received the Best Student Paper Award in Underwater Acoustics at the 139th Meeting of the ASA in June, 2000.

Chel Stromgren received the American Bureau of Shipping Scholarship for FY2000.

Alexandra Techet won the Link Foundation Ocean Engineering and Instrumentation Fellowship for the 1999–2000 academic year, which provides financial support towards stipend, publication costs, and research related expenses.

Irena Veljkovic received the Rosenblith Scholarship for FY2000.

A team of MIT students, (including one from Ocean Engineering) and alumni won the 2nd annual International Underwater Autonomous Vehicle competition held in Panama City, Florida last summer. This marked the second straight year that MIT's submarine, the ORCA-1, finished first among entries from schools such as the University of Florida, Johns Hopkins University, and the Naval Academy of Annapolis, MD.

Martin A. Abkowitz International Fellowship Program
The following individuals were awarded the Martin A. Abkowitz International Fellowship: Dr. Franz Hover for his participation and presentation in June, 2000 of two papers, one at the IUTAMS Symposium on Bluff Body Wakes and Vortex-Induced Vibrations in Marseille, France and one at the 7th International Conference on Flow-Induced Vibrations in Lucerne, Switzerland; graduate student, Alexandra Techet also received a fellowship which she will use to attend the Fluid Dynamics Meeting of the American Physical Society in Washington, D.C.

Robert Bruce Wallace Prize
The winner of the 2000 Wallace Prize, which is awarded to an outstanding undergraduate in the Department of Ocean Engineering, was Ian McCreery. Ian was selected from a list of extremely qualified candidates and will be provided a full academic year of tuition and stipend.

T. Francis Ogilvie Lectureship
In October 1999, Professor David A. Mindell presented the fifth annual lecture on "Technology, Archaeology, and the Deep Sea: Current Research and Future Directions." Professor Mindell is the Frances and David Dibner Assistant Professor in the History of Technology in the program in Science, Technology, and Society, at MIT.

MIT NAVAL CONSTRUCTION AND ENGINEERING SHIP DESIGN AND SHIPBUILDING TECHNOLOGY SYMPOSIUM
On May 23–24, 2000, the annual Ship Design and Shipbuilding Technology Symposium, part of a series of symposia and workshops established in 1986, was hosted by the Department of Ocean Engineering at the MIT Faculty Club. This symposium is held to establish and maintain positive communication with industry, Navy Laboratories and Navy programs on research and education issues relevant to the Naval Construction and Engineering curriculum. The 13A graduate Students presented their theses, and six design projects. One of these focused on developing the 21st century strategic sealift ship (FS-21) to satisfy the Army's strategic sealift needs. Another study examined conversion of FFG7 class ships to serve as dedicated mine countermeasures (MCM) ships to operate with deployed naval forces. This ship conversion is called the Near-Term Organic Mine Countermeasures Ship (NMCM). The luncheon speaker, Dr. Owen Cote of the MIT Security Studies Program, spoke about Military Innovation. The banquet speaker was RADM Roland Knapp who spoke on PEO Aircraft Carriers. Over 100 people from academia, industry and the government attended this annual event.

HART NAUTICAL GALLERY
A model of the 1903 America's Cup winner, *Reliance*, now occupies a place of honor in the Hart Nautical Gallery. An event to celebrate the model's arrival was held on October 29, 1999. *Reliance*, designed by Nathaniel G. Herreshoff (1869), was 144 feet long on deck and carried an immense 16,200 square feet of sails, more sail area than any single-masted vessel ever built. The four-and-a-half-foot model, built by Richard "Frenchy" DeVynck, portrays a racing yacht about two months before launching. Funds for the project were donated by Jack and Mary Dema who in turn credit the project to Kurt Hasselbalch, curator of the Hart Nautical Collections.

ALUMNI EVENTS
Our 20th annual reunion was held at the Sheraton Inner Harbor Hotel in Baltimore, MD on September 30, 1999. Professor Chryssostomos Chryssostomidis served as the host at the reception, which was extremely well attended by alumni, faculty, and guests.

FUTURE PLANS

A major revision of the departmental research brochure is underway highlighting the department's educational and research progress. In addition, the department has started preparation for the ABET review which is due in the Fall of 2001.

Planning continues for the Centennial celebration of the commencement of the XIII-A program at MIT. In 1901 the Navy assigned a small, highly-selected group of officers to MIT for an intensive program in Naval Construction and Engineering. This began a long history of the department providing the core engineering capability for the technical leadership of the US Navy that continues today. A major event will mark this anniversary.

More information about this Department can be found on the World Wide Web at http://oe.mit.edu/.

Chryssostomos Chryssostomidis

DIVISION OF BIOENGINEERING AND ENVIRONMENTAL HEALTH

The Division of Bioengineering and Environmental Health (BEH) officially began operation in July of 1998, with the mission of fostering MIT education and research fusing engineering with biology, and the two ensuing years have been extraordinarily exciting and productive. Our formal Institute mission statement is "To organize education and research at the interface of engineering with biology, with special emphasis on biomedical engineering, pharmacology, and toxicology." The central premise of BEH is that the science of biology will be as important to technology and society in the next century as physics and chemistry have been in the one now ending – especially for application to the field of human health. Therefore, to translate the revolution in modern biology into a corresponding revolution in biology-based technologies, a new biology-based discipline of bioengineering must be established. We must educate engineers and scientists who can: apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions, or subjected to pathogens or toxins; and apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries (as well as in non-health-related industrial sectors such as agriculture, environment, materials, manufacturing, and defense). That is, we must educate a new generation of people who can solve problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems. Hence, a key function of BEH is to create and support curricula in which biology and engineering are taught as synergistically as possible.

BEH has already increased from its initial number of 22 faculty to a current number of 25, with 10 holding primary appointments in the division, 9 holding dual appointments in the division, and 6 holding joint appointments in the division. During the past year, we have hired 2 new dual faculty members, 1 faculty member has moved from joint to dual status, and we have added 1 new joint faculty member. Dual appointments will grow into the major mode as the division continues its increase in size, though new faculty will also be added in the joint and primary categories; our strategic plans calls for the BEH faculty size to approach a total of approximately 35 (with approximately 18–20 "full-time-equivalents") in the coming 5–7 years.

The current primary faculty members are Peter Dedon, Bevin Engelward, John Essigmann (joint appointment in Chemistry), James Fox, Ram Sasisekharan, David Schauer, James Sherley, Steve Tannenbaum (joint appointment in Chemistry), William Thilly, and Gerald Wogan. The current dual faculty members, with their shared appointments noted in parentheses, are William Deen (Chemical Engineering), Linda Griffith (Chemical Engineering), Alan Grodzinsky (Electrical Engineering and Computer Science), Roger Kamm (Mechanical Engineering), Douglas Lauffenburger (Chemical Engineering), Paul Matsudaira (Biology), Dane Wittrup (Chemical Engineering; hired this past year), and Ioannis Yannas (Mechanical Engineering; transferred this past year); in addition, Darrell Irvine (Materials Science and Engineering; hired this past year) will join the dual faculty upon completion of his postdoctoral work (at Stanford University Medical School in the Department of Immunology). The current joint faculty members are Forbes Dewey (Mechanical Engineering), Neville Hogan (Mechanical Engineering), Ian Hunter (Mechanical Engineering), Alex Klibanov (Chemistry; joined this past year), Robert Langer (Chemical Engineering), and Harvey Lodish (Biology).

Regarding undergraduate education, BEH administers SB Minor programs in Biomedical Engineering and in Toxicology and Environmental Health, along with a newly-established 5-year M.Eng. program in Biomedical Engineering. Regarding graduate education, BEH runs SM and PhD programs in Bioengineering and in Toxicology.

Research activity by BEH faculty is conducted under the auspices of a variety of major inter-departmental laboratories and centers, including four headed by BEH faculty: the Center for Biomedical Engineering (Alan Grodzinsky, Director), the Center for Environmental Health Sciences (William Thilly, Director), the Division of Comparative Medicine (James Fox, Director), and the Biotechnology Process Engineering Center (Douglas Lauffenburger, Director). Even outside these formal laboratory/center administrative units, much of the research led by BEH faculty involves multi-disciplinary collaborations with investigators in other MIT academic units as well as in industry and academia elsewhere. As we continue to grow our BEH faculty and facilities, we are placing strategic emphasis on four research areas that permit innovative application of our unique fusion of biology and engineering: cell and tissue engineering; molecular therapeutics (including protein and nucleic acid) discovery, design, and delivery; new tools for pharmacological, toxicological, and genomic studies; and biological imaging, measurement and modeling.

Finally, in April 2000 we held the inaugural meeting of the BEH Visiting Committee. Under the superb leadership of Committee Chair Susan Whitehead, this two-day event provided a wonderful opportunity to have our aims,

activities, and plans assessed critically by a diverse group of external experts. We were gratified by the enthusiastic response of this Committee to the presentations by and meetings with BEH faculty and students, and our efforts in the coming years will be guided very beneficially by the thoughtful advice offered by the Committee members.

During fiscal year 2000, the sponsored research volume for BEH was $4.3 million. This represents only those sponsored projects assigned to the division. Many BEH faculty members have sponsored research projects assigned to other departments, labs and centers.

UNDERGRADUATE EDUCATION

With the formation of BEH in July of 1998, there was created an appropriate academic "home" for the Minor degree program in Biomedical Engineering (BME). This program had been overseen by Professor Roger Kamm via the Center for Biomedical Engineering since the Minor's inception in 1995. Immediately upon the establishment of the new division, however, the administration of the BME Minor was transferred permanently to the BEH Academic Office.

Moving the BME Minor to a central departmental office has proven to be beneficial. Debra Luchanin, Academic Administrator for BEH, now oversees the administration of the program, and keeps formal records on student enrollment, withdrawal, and completion. In addition, program information has been revised and redesigned.

The BME Minor continues to attract a steady number of undergraduates. Eighty-four students were enrolled in the program during 1999–2000 and 28 seniors were awarded the Minor degree at Commencement. Most of the students are drawn from Chemical Engineering, Biology, Electrical Engineering, or Mechanical Engineering.

Generous funding from the Whitaker Foundation has enabled us to establish several Bioengineering Undergraduate Research Awards to be distributed each year, beginning in 1999–2000. Students enrolled in the BME minor receive preference for these awards, which were given to support bioengineering UROP projects. Thirteen students each received $1,200 of research support during the academic year; additional six students were each awarded $4,400 of support for their summer 2000-research projects. BMES members continued to be active; among other activities, they assisted with the Academic Midway and the Pre-Frosh Preview, and organized a Career Fair.

One concern about the BME minor has been the relatively high withdrawal rate from the program. Between 25–30% of those who enroll in the Minor do not complete the requirements. We are now beginning to track formally the reasons given for withdrawal. The program is certainly one of the most rigorous, and students often site a lack of time to complete all of the courses as being the primary reason for dropping the Program. In order to help alleviate the heavy course load, the required Science Core and Bioengineering Core courses were recently modified to allow for more flexibility. The BEH Academic Administrator will continue to monitor the withdrawal rate and to collect information from those who drop the program to determine if there are additional future modifications to be implemented in order to improve the program's retention rate.

A new BEH-administered undergraduate Minor degree program—in Toxicology and Environmental Health (TEH) —began accepting formal enrollment in Fall 1999. The goal of this new Minor is to meet the growing demand for Undergraduates to acquire the intellectual tools needed to understand and assess the impact of new products and processes on human health, and to provide a perspective on the risks of human exposure to synthetic and natural chemicals, physical agents, and microorganisms. Given the importance of environmental education at MIT, the program is designed to be accessible to any MIT Undergraduate. Requirements include three didactic core subjects, a newly created laboratory subject "Laboratory Fundamentals in Biological Engineering," and one restricted elective. Eight students, mostly Biology majors, enrolled in the TEH minor; three of those completed the program and graduated in June, 2000. An informational Open House about the TEH minor was held in April and attracted more than 60 interested students. We eagerly anticipate future enrollment of 20–25 students per class as more students become aware of this program.

GRADUATE EDUCATION

The existing Toxicology Graduate Program was placed under the auspices of the BEH in July 1998 with minimal disruption. Forty-two students were enrolled in 1999–00; five graduated during the year (2 PhD; 3 SM). Zachary Shriver received the Whitaker Health Sciences Fund Fellowship, a competitive MIT fellowship awarded by the Graduate Dean's Office. Three students received Fellowships from sponsors outside of MIT: Marita Barth and Carrie Hendricks are supported on Department of Defense Fellowships, and Cecilia Fernandez continued to receive a Ford Foundation Fellowship for Minorities. Nishla Keiser has been selected to receive a NSF Fellowship in

2000–2001. Toxicology admissions appeared not to have been affected by the move to BEH. We received 40 applications for admission in 2000, which is similar to the number received in previous years. Of the 12 admitted to the program for September 2000, eight have accepted our offer to join the Toxicology Ph.D. program.

Completely independent of the move to BEH, a revised TOX Ph.D. curriculum was implemented in Fall, 1999. Most significant was the introduction of a half-term format for several required subjects. The revised curriculum allows for focus on fewer problems in greater depth and the incorporation of new disciplines (e.g., cell kinetics, extracellular matrix) into the curriculum. In addition, students are introduced to the primary literature earlier and more often. Structured in several two-week sessions in which students apply basic facts/concepts/methods to problems in toxicology, the new BEH.203 course addresses students' possible need for remediation in organic chemistry, molecular biology, cell biology, physical chemistry, mathematics or other areas.

The new Ph.D. program in Bioengineering was introduced in Fall, 1999 with a class of eleven students. The outstanding caliber of this inaugural group was confirmed by the fact that three from this group were awarded the prestigious Whitaker Foundation Fellowships to support their work in bioengineering. The students' first-year curriculum included four common core bioengineering courses and additional electives. All eleven students passed the Written Qualifying Exams in May and have subsequently joined research lab groups. Applications to the Bioengineering program in 1999–2000 were nearly double (128) that received for the first year (67) of the program. Seventeen applicants were offered admission, nine of whom accepted our offer. In addition, two students who previously deferred enrollment will be joining the class entering in September, 2000 for a total of eleven new students. Among that group, four have been awarded Whitaker Foundation Fellowships, and one has been awarded an NSF Fellowship.

Of the entire pool of 1999–2000 applicants to BEH, ten were members of under-represented minority groups: African American (6), Mexican American (2), Puerto Rican (2). Three minority applicants were offered admission; two accepted the offer to join the BEH Ph.D. program and one chose, instead, to enroll in the Department of Electrical Engineering and Computer Science Ph.D. program at MIT. One of the minority students who accepted our offer of admission has been awarded a Leventhal Fellowship by the MIT Graduate Deans' Office; the other newly admitted student has been selected for as a recipient of a very prestigious GEM (Graduate Degrees for Minorities in Engineering/Science) Fellowship.

FACULTY NOTES

Honors and Awards

Professor Peter C. Dedon—Edgerly Science Partnership Award with Professor Peter So.

Professor Bevin P. Engelward—Burroughs Wellcome Fund New Investigators Award in the Toxicological Sciences (2000).

Professor John M. Essigmann—Award for Scientific Excellence in Mutation Research. He was nominated for this award by the American Chemical Society.

Professor James G. Fox—1999 AALAS N.R. Brewer Scientific Achievement Award.

Professor Robert S. Langer—Honorary Doctorate (The Catholic University of Louvain, Belgium); Glaxo Wellcome Award (Royal Pharmaceutical Society of Great Britain); Millenial Pharmaceutical Scientist Award (Millenial World Congress of Pharmaceutical Sciences); First Pierre Galletti Award (American Institute of Medicine and Biological Engineering); Wallace Carothers Award (American Chemical Society, Delaware Section).

Professor Douglas A. Lauffenburger—Elected Chair of the College of Fellows, American Institute of Medical and Biological Engineering; Amgen Award in Biochemical Engineering from the Engineering Foundation.

Professor L. Mahadevan—Honors: Office of Naval Research Young Investigator Award; Society of Engineering Science Young Investigator Medal; Edgerton Award for Faculty Achievement, MIT

Professor James L. Sherley—Charles E. Reed Faculty Initiatives Fund Recipient; Samuel A. Goldblith Career Development Professorship.

Professor K. Dane Wittrup—Fellow in the American Institute of Medical and Biological Engineers; the University of New Mexico College of Engineering Distinguished Young Alumnus for 1999.

Invited Lectures, Committees and Research

Professor Peter C. Dedon organized and chaired a symposium, "Mechanisms of Action of Cytotoxic Agents," at the 201st meeting of the American Chemical Society, San Francisco, 3/29/00. The symposium will be featured in an upcoming issue of Chemical Research in Toxicology as a "symposium-in-print."

Research Accomplishments

The past year has seen major research accomplishments in three areas. First, in our studies of novel DNA adducts arising from oxidative DNA damage, we have identified a novel cytosine adduct formed by cis-2-butene-1,4-dial, a product of 5'-oxidation of deoxyribose. We have also defined the mechanism by which glyoxal adducts in DNA arise, namely by a phosphonate-release from the phosphoglycoaldehyde residue arising from 3'-deoxyribose hydrogen atom abstraction. The goal for the coming year is to quantify both adducts in cells exposed to oxidative stress.

In a second avenue of study, we have identified a bacterial enzyme, alkA, that repairs deoxyxanthosine, the deamination product of deoxyguanosine in DNA. This is a critical step in our efforts to distinguish base deamination caused by nitric oxide from base oxidation caused by peroxynitrite, two related and genotoxic chemicals produced by macrophages.

Finally, Professors So and Dedon were awarded an Edgerly Science Partnership Award to study the effects of positive DNA supercoiling on DNA structure and protein interactions. We have determined that positive supercoiling, which is produced during DNA transcription and replication, increases the reactivity of DNA bases toward genotoxic chemicals. This is consistent with flipping of the bases out of the DNA helix as the DNA becomes overwound. We are currently investigating the effects of positive supercoiling on DNA-directed enzymes that rely on base flip-out to perform their catalytic activity.

Professor William M. Deen was an invited speaker at a symposium on membrane science at the AIChE Annual Meeting in Dallas, Texas on November 2, 1999. He was also an invited speaker at a symposium on the kidney microcirculation at the meeting of the European Society for Microcirculation in Stockholm, Sweden, on June 5, 2000. His laboratory continued its investigations in the areas of hindered transport in fibrous media, water and macromolecule filtration in kidney capillaries, and physico-chemical aspects of nitric oxide toxicity and carcinogenicity.

Professor Bevin P. Engelward—Research Accomplishments: Although we know that homologous recombination events promote tumorigenesis, we know almost nothing about what causes these events in mammals. One of our major goals is to engineer a system for detecting homologous recombination events in mammals. This year, we have genetically engineered a substrate for detecting recombination in mammals, we have demonstrated that recombination of our engineered substrate yields a strong fluorescent signal, and we are currently doing experiments to establish transgenic animals in which recombination events can be detected by a fluorescence *in situ*.

Innovative tools to detect homologous recombination can ultimately be used to help reveal the genetic and environmental factors that promote genetic changes that lead to cancer. Alongside tool development, we are also studying the interplay of DNA damage, repair and recombination in model systems. We are particularly interested in endogenous and environmental agents that cause genetic changes. Nitric oxide is an endogenously produced DNA damaging agent that is associated with chronic inflammation. Despite a tremendous amount of research directed at understanding the biological effects of nitric oxide exposure, almost nothing was previously known about the mechanisms that cells use to prevent nitric oxide induced toxicity. We have discovered that mitotic recombination is a pivotal defense against nitric oxide induced toxicity. In addition, we found that a side effect of recombinational repair is that nitric oxide can cause aberrant homologous recombination. The discovery that nitric oxide is as potent a recombinogen as is UV light introduces a novel potential mechanism for the well established association of inflammation and tumorigenesis.

Professor John M. Essigmann—This year the Essigmann group made progress in the following areas. First, they reported the first system by which the mutagenic activity of a DNA adduct could be determined in all possible sequence contexts. Results showed that DNA repair proteins selectively repair adducts in some contexts *in vivo*. Second, they showed that nearly all known recombination systems play a critical role in helping *E. coli* defend

against the anticancer drug cisplatin. They proposed a model whereby the interplay of mismatch repair and recombination systems selectively sensitizes germ line tissues to cisplatin. Third, they have designed an improved selective toxin for tumor cells that express the estrogen receptor. They showed that the receptor binds to the adducts and shields them from repair. They are now in the process of linking other DNA damaging agents to the receptor ligand and are at mid-course in a series of animal studies aimed at establishing antitumor efficacy *in vivo*.

Professor James G. Fox—Distinguished Veterinary Medicine Sesquicentennial Lecturer, University of Wisconsin, Madison WI; Appointed to Editorial Board of Journal of Experimental Medicine and Biology; Appointed to Board of Trustees Association of Accreditation and Assessment of Laboratory Animal Care; Presented 24 invited lectures at various national and international meetings and academic institutions; list available on request –Published 15 papers and 7 chapters

Professor Linda Griffith—Linda Griffith continues to serve as PI on a DARPA project to develop tissue-based sensors for biological warfare agents. She also continues work in the area of new polymers for tissue engineering and cell biology. She chaired a NIH workshop on Tissuegenesis and Organogenesis for the National Heart, Lung, and Blood Institute, and was elected to serve on the Surgery and Bioengineering Study section. She gave several invited talks at conferences, other universities, and government panels. At MIT, she continues to serve as the Associate Director of Education for BPEC and as head of the Biotech Student Leadership Council.

Professor Neville Hogan—In the past year our ongoing studies have confirmed the lasting benefit of using robots for neurologic rehabilitation. Robot sensory-motor therapy improved the motor ability of stroke patients' treated limbs twice as much as conventional (manual) therapy alone; and this advantage was sustained for at least three years. (Neurology 53:1874–1876, 1999; Neurology 54:1938–1944, 2000; see also brief media coverage in *US News and World Report*, 6/26/00 and http://web.mit.edu/newsoffice/rd/2000/jul.html).

Professor Roger D. Kamm—Major research accomplishments include: Have identified using AFM the process of filament formation and structure in the development of a network with various biomaterial applications. Developed computational models for deformations of neutrophils or epithelial cells subjected to a variety of mechanical forces. Obtained industrial funding (2 yrs, $250K/yr) to study the stimulation of angiogenesis by means of external compression of the lower extremities.

Professor Robert S. Langer—Herman Beerman Lecturer (Society of Investigative Dematology); Bayer Lecture (University of Massachusetts at Amherst); William G. Lowrie Lectureship (The Ohio State University); Frank T. Gucker Lecturer (Indiana University); First pattern Distinguished Lectureship (University of Colorado at Boulder);

Professor Douglas A. Lauffenburger—elected as Chair-Elect of the College of Fellows of the American Institute of Medical & Biological Engineering. He was also appointed to serve on the Advisory Committee of the Burroughs-Wellcome Program on Interfaces Between the Physical, Chemical, and Computational Sciences. In addition to being Co-Director of BEH and the Biotechnology Process Engineering Center (BPEC), he was appointed Associate Director of the MIT-DuPont Alliance in Bio-Based Materials.

Professor L. Mahadevan—My research continues in two directions: the physics of interfaces and thin solid and liquid films, and molecular and cellular biomechanics. In the past year, my group has made some advances in understanding the structure and formation of singularities in elasticity and hydrodynamics, and has begun to work on problems associated with motility in biological machines, such as the acrosomal process in Limulus and polymerization-driven motion in Listeria.

Professor David B. Schauer—Received tenure at MIT and has become an Adjunct Associate Professor at the Tufts University School of Veterinary Medicine. Research Accomplishments: In the past year his lab has identified and characterized cytolethal distending toxin as a candidate virulence determinant in *Helicobacter* species. His lab has also successfully generated isogenic mutants of *Helicobacter* that they are using to test the role of this and other candidate virulence determinants in cell culture and *in vivo*.

Professor James L. Sherley—New York University School of Medicine, Cellular and Molecular Biology Training Program Retreat, Keynote Speaker, "Back to the Future p53 Gene Function in Healthy Cells"; Tennessee State University, 22nd Annual University-Wide Research Symposium Keynote Speaker, "Informing the Public in Environmental Health Science: Who, How, and Why?"; Editor, Journal of Biomedicine and Biotechnology. Major Research Accomplishments:

- Demonstrated that rat liver epithelial cell lines derived by pharmacological suppression of asymmetric stem cell kinetics have hepatocyte stem cell properties.

- Filed MIT Technology Disclosure for a method to isolate and propagate somatic tissue stem cells in culture.
- Established cytological evidence that cells with asymmetric stem cell kinetics preferentially retain "immortal" template DNA strands as first postulated by John Cairns in 1975.

Professor Steven R. Tannenbaum—Invited Lectures: U.S.-Japan Program, "Chronic Inflammation and Cancer"; University of Pennsylvania, "DNA Damage via Peroxynitrite"; Texas A & M, "Nitric Oxide and DNA Damage"; Oregon State/Linus Pauling Institute, "Nitric Oxide and DNA Damage." Committees: Steering Committee – New England Drug Metabolism Discussion Group; U.S. Air Force – Scientific Advisory Board (ad hoc); NAS/NRC – Stockpile Committee; Institute of Medicine – Vice Chair of Section 1 and Membership Committee.

Our research group continues to make progress along several fronts:
- Nitric Oxide: We have fully characterized all of the major reaction products of deoxyguanosine with NO oxidation products. Characterization of reaction products of oligonucleotides and DNA is in progress.
- Biomarkers: A major bladder cancer case-control study is near completion and will correlate 4-aminobiphenyl adducts with diet, lifestyle, and cancer risk. Important progress has also been made on substituted anilines and heterocyclic amines.
- Liver Biochips: Development of 2-D and 3-D structures for toxicology and drug metabolism is in progress.
- Accelerator Mass Spectrometry: The instrument is near operational and can be used for in-line chromatographic analysis.

Professor K. Dane Wittrup joined the faculty as a two-key Professor in the Department of Chemical Engineering and the Division of Bioengineering and Environmental Health in August 1999. He was invited to present the Colburn Lectureship at the University of Delaware, as well as ten other invited talks, including the NAE German-American Frontiers of Engineering, University of Connecticut and University of Wisconsin/Madison. He currently serves on the national Awards Committee of AIChE.

Professor Gerald N. Wogan—Professor Gerald N. Wogan received appointments as: Princess Takamatsu Cancer Research Fund Lecturer in Japan; Scientific Advisor to the Laboratory of Human Carcinogenesis at the National Cancer Institute; and Visiting Professor in the Department of Environmental Health Sciences at the Johns Hopkins University School of Hygiene and Public Health. He was elected Chairman of the Division of Chemical Toxicology of the American Chemical Society. He serves as a member of the National Advisory Environmental Health Council of NIH and the Operating Board of Directors of the Chemical Industries Institute of Toxicology. He also holds memberships in the External Science Advisory Committees for the Comprehensive Cancer Centers of the University of Colorado and the University of Minnesota, as well as the Center for Research on Environmental Disease of the University of Texas, MD Anderson Cancer Center.

Professor Ioannis V. Yannas—Dinner Lecturer at Royal College of Engineering, London, UK, "The Future of Tissue Engineering."

RESEARCH NEWS

Peripheral nerve regeneration studies based on several tubular devices have yielded long-term (60-week) data on axonal structure at near-terminal locations. These devices were used to bridge a 10-mm gap in the transected rat sciatic nerve. One device, a collagen tube filled with a highly porous ECM analog (the nerve regeneration template) led to formation of axonal structure at near-termainal locations which was significantly closer to normal structure than that obtained using autograft controls, the current "golden standard" of peripheral nerve repair (Chamberlain *et al.*, J. Neurosci. Res. 60, in press).

A new theory for peripheral nerve regeneration has been proposed based on the recent discovery of a tight capsule of contractile cells (differentiated fibroblasts) around neuromas (stumps that have been allowed to heal without tubulation treatment) or around the small-diameter nerves which are known to regenerate when a gap in the nerve has been bridged with a silicone tube. In contrast, a very thin contractile cell capsule formed around nerve regenerated inside a collagen tube. The novel theory described nerve regeneration across a gap in the transected nerve as resulting from a balance between two competitive mechanical forces: the axial forces generated by the outgrowth of axons and non-neuronal cells from the proximal stump and the constrictive forces imposed by the contractile cell capsule that promote wound closure at the stump site (Chamberlain *et al.*, 2000, J. Comp. Neurol., 417: 415–430).

More information about the division can be found on the World Wide Web at http://web.mit.edu/beh/.

Douglas A. Lauffenburger, Steven R. Tannenbaum

ENGINEERING SYSTEMS DIVISION

Founded in 1998, the Engineering Systems Division (ESD) is an integrative interdisciplinary unit of MIT's School of Engineering that brings together and builds upon the work of several existing academic programs and research centers. The academic programs include Leaders for Manufacturing, System Design and Management; Technology and Policy Program; Master of Logistics and Master of Science in Transportation. The research centers include the Center for Innovation in Product Development; the Center for Technology, Policy, and Industrial Development; the Center for Transportation Studies; and the Industrial Performance Center. Approximately 345 graduate students were enrolled in ESD-affiliated academic programs in the past year, while the research volume was approximately $16 million.

Much has been accomplished within the Division this year including appointing the initial ESD faculty members, searching for new faculty, developing a mission statement and goals and objectives for ESD, establishing governance and administrative structures, reviewing and assessing ESD-affiliated academic program and initiating new educational and research programs.

FACULTY

The most important step in creating ESD was appointing the initial ESD faculty. Twenty-two faculty were appointed; fifteen in engineering and seven in management. These appointments are made in conjunction with an academic department. All Sloan School appointments are joint with ESD. Twelve Engineering School appointments are dual and three are joint. Discussions are ongoing with additional faculty and their department heads about further faculty appointments to ESD.

An ESD Faculty Search Committee was formed. To date, an offer has been made to and accepted by David Simchi-Levi, who joined the MIT faculty on July 1, 2000 as a dual appointment between Civil and Environmental Engineering and ESD. David comes to MIT as a full Professor from Northwestern University. His work spans a wide spectrum of research, focusing primarily on vehicle routing and scheduling of transportation systems and supply chain management, where he has made significant contributions to both theory and practice.

NEW MISSION STATEMENT

The field of engineering is changing rapidly. System and product complexity are increasing at an accelerating pace, as are the complexities of operating in a global context where technical, natural, and social systems increasingly intersect. Engineering system professionals must consequently consider the technological components as part of a larger engineering system and utilize different approaches than those based on the traditional engineering science. Therefore, for MIT to continue its leadership role in the next century the Institute must broaden engineering education based on an engineering systems perspective. These concepts gave rise to the following mission statement:

> ESD will establish engineering systems as a field of study focusing on complex engineering systems and products, where these systems and products are viewed in their broad social and industrial context, and will use the new knowledge gained to improve engineering education and practice.

GOALS AND OBJECTIVES

ESD will be an intellectual home for faculty from engineering, management, and the social sciences, committed to collaborative, integrative, interdisciplinary programs in complex engineering systems serving societal and industrial needs.

ESD will develop concepts, frameworks and methodologies that codify knowledge and define engineering systems as a field of study.

ESD will introduce engineering systems into the mainstream of engineering education, by working with the MIT engineering departments, the Institute as a whole, and other engineering schools worldwide.

ESD will educate MIT students to be tomorrow's engineering leaders via innovative academic and research programs.

ESD will work in partnerships with government and industry to initiate research on problems of national and international importance, as well as projects that demonstrate the changing roles of university, industry, and government in all aspects of engineering systems research, development and deployment.

GOVERNANCE

During the year, ESD appointed an Associate Director, Professor Paul Lagace, to oversee current and developing ESD academic programs. In addition, an Assistant Director was appointed to oversee administrative functions in December. An ESD Council was formed to provide advice to the Director and an ESD Visiting Committee, chaired by Norman Augustine was appointed by the MIT Corporation.

ACADEMIC PROGRAMS

Much has been accomplished in ESD academic programs during the past two decades. They differ from traditional MIT academic programs in the following respects:

- they are interdisciplinary;
- many students are older, with several years of professional work experience; and
- in addition to traditional subjects, the programs emphasize leadership, team building, and internship experiences.

The existing graduate educational programs focus on professional practice. These are "stand alone" programs without linkages to more advanced graduate degrees. An ESD objective is to develop coherent graduate tracks for the various professional practice degrees and to enable graduate students to easily move between the traditional research oriented and professional practice degrees. Work has begun on these issues during the year.

Developing the ESD Ph.D. is our most challenging undertaking. We have examined experience to date with the two current ESD Ph.D. programs in Technology, Management and Policy, and Transportation. Our continuing process is to develop subjects that would serve as a core ESD curriculum. Many ESD faculty believe we will identify several core methodologies and tracks rather than a single ESD Ph.D. curriculum.

ESD is developing system case studies to be used in ESD-affiliated educational programs. The ESD educational programs need good examples of the way engineering systems design can best be handled in practice. Real-world experience provides a vital understanding of issues and motivates the use of the most effective analyses. The development of real-world examples for students to analyze as class exercises is a top priority for improving our instruction. These case studies will be developed so that they can be used in a number of classes. Much work was done this year on case study development under the direction of Professor de Neufville.

Other ESD educational initiatives include development by Professors Lagace and Eagar of a new freshman elective "Essentials of Engineering," and planning for a new undergraduate systems minor by Professors Sussman and Nightingale.

Cambridge-MIT Institute

An important component of ESD's strategic plan is the establishment of an international engineering systems network work with a limited number of peer academic institutions around the world. The first step involves the Cambridge-MIT Institute (CMI), a new form of academic enterprise bringing together two of the world's great universities to build on the complementary strengths of each. The partnership focuses on university/industry relationships and issues of competitiveness, performance, productivity, and entrepreneurship. Since these topics are all of particular relevance to ESD, the Division will assume a major role in CMI.

ESD participation will occur in two of the four CMI's thrust areas: professional practice programs and competitiveness research. The U.K. government, the sponsors of the CMI, would like MIT to transfer its professional practice programs (i.e. LFM, SDM, MLOG, TPP etc.) to the UK. An opportunity also exists to develop short courses, systems studies and new professional practice programs. In addition, the ESD research centers will sponsor projects and programs examining competitiveness issues. Therefore, CMI will be of great benefit in expanding existing projects and initiating new projects.

More information about the Engineering Systems Division can be found on the World Wide Web at http://esd.mit.edu/.

Daniel Roos

ARTIFICIAL INTELLIGENCE LABORATORY

The MIT Artificial Intelligence Laboratory has as its principal intellectual goal the understanding of human intelligence. As a practical matter the AI Lab develops the mathematics and engineering of intelligent systems and artifacts.

The MIT AI Lab has been in continuous existence since 1959, and currently has 24 faculty and senior and principal research scientists. The majority of faculty come from the department of Electrical Engineering and Computer Science, along with some from Brain and Cognitive Science, Mechanical Engineering, and Aeronautical and Astronautical Engineering.

Financial support is provided by the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), Nippon Telegraph and Telephone (NTT), Ford Motor Corporation, Yamaha Motor Corporation, the EPOCH Foundation (Taiwan), Flex Foot Inc., Alphatech Inc., Amgen Inc., Mitsubishi Research Laboratories, and Microsoft.

During the last year the AI Lab continued in its lead role for the NTT/MIT collaboration. Through this collaboration seventeen projects were funded in the AI Lab and the Laboratory for Computer Science. This collaboration is slated to run for three more years until June, 2003.

The AI Lab began a new collaboration with the Laboratory for Computer Science on MIT Project Oxygen. This project aims to create pervasive human-centered computing as the new way that people interact with computers. Along with LCS, the AI Lab has secured funding from DARPA for this project, and has set up an industrial collaboration with Hewlett-Packard, Acer, Nokia, Delta, Philips, and NTT.

The research activities of the laboratory are divided into eleven general areas: learning, core artificial intelligence, information management, medical vision, general vision, vision applied to people and activity, medical robotics, robotics, cognitive architectures, language, and new models of computation. Two page research abstracts of 134 individual projects at the lab can be found at http://www.ai.mit.edu/lab/abstracts/1999/. Some of the highlights of the year are as follows.

Professor Leslie Kaelbing and her students made progress on making reinforcement learning practical on real robots. Professor Tommi Jaakkola has applied kernel methods and graphical models to biological problems such as protein sequence analysis and gene identification, and to large scale medical diagnosis problems. Professor Tomaso Poggio and his students have extended their theoretical results on Support Vector Machines, and have investigated learning mechanisms in visual cortex.

Professor Tomaso Poggio and his students have studied artificial markets, Professor Tomas Lozano-Perez and his students have studied search methods with applications to understanding protein folding, and Dr. Olin Shivers and his students have worked on formal methods in specialized computer languages.

Mr. Michael Coen and a large number of graduate and undergraduate students have developed new applications for the Intelligent Room—in particular they have continued the development of the MetaGlue agent programming system. Professor Randall Davis and his students have developed systems that allow users to sketch mechanical designs, and transforms those sketches into formal mechanical descriptions which can be manipulated by simulation software. Dr. Howie Shrobe and Professor Davis have worked together on complementary aspects of design automation, namely design rationale capture, so that besides the design itself being produced, it is tagged with the inner thoughts of the designers elaborating on their design choices. Dr. Shrobe and Dr. Bob Laddaga have developed new techniques for making software self adaptive. Professor Lynn Stein has collaborated with Professor David Karger of the Laboratory for Computer Science, on personalized information environments for navigating the world wide web.

Professor Eric Grimson and his students have worked on a wide variety of visual techniques specialized to many different anatomical regions to support surgery, diagnosis and training. These methods and applications have included MRA segmentation, understanding vasculature images, orthopedic imagery, brain tumors using MRI, surveying sources of pediatric epilepsy, and three dimensional reconstruction, registration, tracking, and

visualization. Professor Berthold Horn and his students have worked on new methods of tomography using incoherent lights sources, rather than more specialized radiation sources.

Professor Edward Adelson and his students have worked on understanding material properties from images, intending it as a source of constraint, ultimately, in object recognition. Professor Berthold Horn and his students have studied analog circuit for image smoothing and segmentation directed towards building smarter chips for vision. Professor Paul Viola and his students have developed new techniques for understanding hand writing, and for automatic target recognition. Visiting Professor Lisa McIlrath and her students have developed new VLSI based circuits for early image processing.

Prof. Tomaso Poggio and his students built a system that produces photo realistic text to audio-visual speech synthesis, and built reliable static face detectors. Professor Paul Viola and his students built a real-time face detector that is able to recognize faces as people walk along corridors. They continued their work on a system which uses multiple cameras at fixed positions, and is able to produce three dimensional reconstructions of people moving through the area. Professor Eric Grimson and his students further developed their work with cameras tracking people and vehicles, including new classification techniques, solving for the three dimensional relationship between cameras whose viewpoints partially overlap, and carrying out detailed geometric analyses of motion. In November of 1999, Professor Trevor Darrell joined the MIT faculty and the Artificial Intelligence Lab. He has set up a new perceptual interface program, using cameras in intelligent rooms, and new theoretical constraints applied to real-time stereo of people moving about, gesturing, and producing facial expressions.

The Artificial Intelligence Lab has become involved in a number of projects in applying robotics to medical applications. These include new artificial knees and legs for amputees (Dr. Hugh Herr), laproscopic surgery simulation (Dr. Ken Salisbury), robotic wheelchairs (Ms. Holly Yanco working with Professor Rodney Brooks), simulation of arthoscopic surgery (Professor Eric Grimson), and understanding low level motor control in humans (Professor Steve Massaquoi).

Professor Gill Pratt and his students have worked on a large number of walking robots. They have built a new bidpedal walking robot called M2. They have continued their work on the dinosaur robot Troody, and they have furthered the development of series-elastic actuators. Dr. Ken Salisbury and his students have developed new techniques for haptic interaction, and have investigated autonomous digging robots for subsurface planetary exploration.

Professor Rodney Brooks and his students have worked on a number of robots, Cog, Kismet, Coco, and the M4 Head, incorporating complete cognitive architectures with them. Dr. Cynthia Breazeal working with a number of other students built a broad cognitive architecture for Kismet, based on an underlying emotional state. Subsystems included a visual attention system, a system that understand prosody in people's voices, an affect-based phoneme generation system, and facial emotional display system, behavior releasing system, and system for taßπking turns with people in interactive speech. Together they allow Kismet to interact with naïve subjects, engaging in emotion laden, but meaning-free conversations.

Dr. Boris Katz and his students have applied natural language techniques to information retrieval problems, especially on the Web. They have been developing systems which can understand the content of the Web, or can be annotated in English, so that the right information is retrieved in response to an English language query.

Dr. Tom Knight and his students have developed a way of getting digital control over the molecular biochemistry of living cells. The system compiles simple computation into DNA strings which get inserted into living E. Coli cells. The group demonstrated molecular signaling on one class of cells, which did a simple digital computation and molecularly signaled another class of cells, which did a further simple computation and changed the cells' luminescence to indicate the result. Dr. Knight and his students also worked on new silicon-based architectures where fine-grain data ownership is enforced at the lowest levels in order to provide a new class of security implementations. Professors Abelson and Sussman have continued their work developing computation on amorphous structures.

More information about the AI Lab can be found on the World Wide Web at http://www.ai.mit.edu/.

Rodney A. Brooks

BIOTECHNOLOGY PROCESS ENGINEERING CENTER

The Biotechnology Process Engineering Center (BPEC) is a multi-disciplinary body with faculty members from the MIT Departments of Biology, Chemistry, and Chemical Engineering, the Division of Bioengineering and Environmental Health (BEH), and the Whitehead Institute for Biomedical Research, along with the University of Toronto Department of Chemical Engineering and the Brown University School of Medicine Liver Center. The mission of BPEC is to carry out research and education combining engineering with molecular biology, emphasizing a strong relationship with industry in its various activities. The goals of the center are to perform cutting-edge, fundamental research in therapeutic gene and protein biotechnology based on contributions from, and interactions among, investigators from diverse relevant backgrounds.

While the mission of BPEC has remained unchanged since its inception in 1985, the central focus of BPEC's research directions has now successfully completed a major transition from the previous Therapeutic Protein Biotechnology (TPB) thrust to a new Therapeutic Gene Biotechnology (TGB) thrust. The TGB thrust is now being primarily fostered by the National Science Foundation Engineering Research Center core funding, while support for the TPB thrust is provided by various governmental agency and industry grants. Central issues which are being addressed in the TGB thrust include problems associated with development of selective gene delivery vehicles for both *ex vivo* and *in vivo* approaches; the former emphasizes hematopoietic stem cells grown in culture and infected with viral vectors before implantation, whereas the latter emphasizes ligand-targeted synthetic or viral vectors with liver as a chief tissue objective. In the past year, we have added three new BPEC team investigators and one new collaborator, in order to address additional challenges as recommended by our Industrial Consortium Advisory Board and previous NSF review panel.

Educational programs of BPEC deal with the needs of undergraduates, graduates and industrial personnel. The goals of the educational programs are to provide integrated and broad bioengineering perspectives to the students; at the undergraduate level we now participate in the Biomedical Engineering Minor offered by BEH to students in all majors, while at the graduate level we likewise participate in the Bioengineering and Toxicology Ph.D. programs offered by BEH along with the traditional Ph.D. programs in Biology, Chemistry, and Chemical Engineering. In addition, NIH Training Programs in Biotechnology and in Genomics are administered from the BPEC office, leveraging the NSF ERC to broader educational opportunities at the engineering/molecular-biology interface. Undergraduate research is achieved through the Undergraduate Research Opportunities Program (UROP) for MIT students and the Research Experience for Undergraduates (REU) for non-MIT students. Special one-week summer courses are offered to industrial personnel.

Industrial activities and planning are coordinated through our new formally-constituted Therapeutic Gene Biotechnology Industrial Consortium Advisory Board (TGB ICAB), supervised by our BPEC team of Industrial Liaison (Matt Croughan) and newly-hired Associate Industrial Liaison (Jean-Francois Hamel). We are extremely pleased by the progress we have made this past year in beginning to reinvigorate our BPEC/industry partnerships following the difficult transition period; this progress can be seen in the highly positive industry SWOT analysis generated at our April 2000 ICAB meeting.

We have added to the BPEC administrative umbrella the new DuPont/MIT Alliance (DMA) in 'Bio-Based Materials,' as another facet of the BPEC mission to combine engineering with molecular biology. This Alliance provides $7 million year to MIT for a 5-year period, and nicely extends the impact of the BPEC engineering/biology collaborative spirit to even broader reaches of the MIT campus and industry.

Statistically reporting, 148 personnel took part in the center's research activities during fiscal 2000. This figure comprises of the following: 57 MIT Undergraduate worked as lab interns (I.e., UROP students), 12 non MIT undergraduates who participated in the center's NSF Research Education for Undergraduates Program (REU); 26 graduate students; 21 postdoctoral associates/fellows; 16 visiting scientists, engineers, industry researchers, six administrative personnel, seven other director level personnel and 12 faculty (some faculty served as executive directors).

MILESTONES AND GOALS

Research

Numerous research milestones were accomplished during fiscal 2000. Listed below are the following "top 10":

- Development of a new methodology for identification of novel genes expressed by hematopoietic stem cells for lineage-committed progenitors.
- Discovery of four novel genes, whose products are secreted or cell-surface proteins from stromal cells, that support hematopoietic stem cell proliferation.
- Demonstration that overexpression of a particular signaling gene, BCR-ABL, in embryonic stem cells, can drive expansion of hematopoietic cell populations.
- Elucidation of a "signaling threshold" model for cytokine control of stem cell proliferation.
- Establishment of a real-time quantitative PCR assay for following the kinetics of plasmid numbers in intracellular compartments following delivery.
- Determination that transgene expression via synthetic vector delivery is influenced by processes related to DNA methylation.
- Demonstration of 2-week retention of serum albumin secretion in tissue-engineering liver microarray.
- Development of on-line assay for P450 enzyme function in tissue-engineered liver microarray, showing activity retention for 8 days.
- Synthesis of novel polymers as synthetic gene delivery vehicles.
- Synthesis of novel peptides as synthetic gene delivery vehicles.

Value-added for industry can be categorized as follows: (a) a multi-investigator, multi-disciplinary academic research unit combining engineering with molecular biology for solving fundamental, generic basic problems posing severe obstacles to the long-term growth of a broad-based therapeutic gene biotechnology industry; (b) an inter-disciplinary academic unit combining engineering with molecular biology in training of the young investigators who will become the foundation of the developing therapeutic gene biotechnology industry; (c) a multi-disciplinary center stimulating dissemination of forefront biotechnology and bioengineering activities into the traditional science and engineering disciplines, bringing new problems and approaches toward their enrichment. A crude under-estimate of the magnitude of the value-added to the United States can be obtained by realizing that approximately 1–2% of pharmaceutical/biotechnology industry revenues is devoted to basic research of the sort fostered by BPEC research efforts and undertaken by researchers of the sort exemplified by BPEC graduates. Accordingly, given that the inter-disciplinary BPEC research activities and BPEC graduates are at the leading edge of what is sought by industry, the roughly $3 million yearly investment from government and industry in BPEC activities can be considered to be leveraged perhaps 50-100 fold into ultimate industrial productivity.

Education

Our objectives remain to impact the education of undergraduate students, graduate students, and industrial personnel in their ability to work at the engineering/biology interface on important problems in biotechnology.

Undergraduate Education

At the undergraduate level, our goal is to ensure the students are integrated into our research thrusts for both MIT (UROP) students and students from other institutions (REU and high schools). To expose the students to cross-disciplinary activities and teamwork, the projects are selected carefully and critically. BPEC provides initial experiences to undergraduates and encourages students to work in industry as internees. Our Industrial Liaison and Education Coordinators contact companies associated with BPEC for summer undergraduate internships and the replies are then matched with BPEC's undergraduates for summer employment.

The Division of Bioengineering and Environmental Health (BEH) has now further enhanced its undergraduate curriculum aimed at integrating molecular cell biology with engineering, by developing a new 5-year SB/MEng program in Bio/Medical Engineering to accompany the onging Bio/Medical Engineering SB Minor program. The BME Minor is MIT's first inter-departmental minor degree, available to undergraduates taking any BS Major degree at the Institute. The program comprises 4 subjects in Bio/Medical Engineering—2 core subjects and 2 electives. These subjects require substantial preparation in science and engineering, and thus the minor is structured in the form of a Science Core (3 subjects) and an Engineering Core (2 subjects) which serve as prerequisites for the Bio/Medical Engineering subjects. The goal of the degree program is to educate students in how to apply fundamental engineering principles to solve challenging problems in biology and medicine. A common theme is the integration of individual components of a biological system to describe both the spatial and temporal organization of the system as a whole. The scale of this integration may be as small as molecules and cells or as large as organ systems or whole

organisms. Students gain an appreciation of how to solve problems at these different scales by taking two core biomedical engineering courses. They can then pursue particular interests through the two restricted electives in bio/medical Engineering.

More than ever, cutting-edge research combining engineering with molecular biology concomitantly requires analogously novel educational programs, and BPEC is at the heart of a radical new academic unit created at MIT this past year: the Division of Bioengineering and Environmental Health (BEH). BEH is a departmental structure within the School of Engineering charged with creating and administering educational and research programs that forge engineering with modern biology. Rather than focusing on a particular application field like most 'biomedical engineering' departments being created across the country, BEH is focused on fostering a new discipline of biological engineering that will educate engineers to create technologies based on molecular biology whether the application area is medicine, environment, agriculture, materials, manufacturing, or so forth. BEH has initiated a new Bioengineering Ph.D. program with a novel core curriculum aimed at training this type of next-generation biotechnologist, alongside students trained in inter-disciplinary fashion in the MIT Departments of Chemical Engineering, Chemistry, and Biology—with all these programs intertwined through the NIH Training Programs in Biotechnology and Genomics also administered by BPEC.

Graduate Education

At the graduate level, one of the goals of BPEC is to provide research experience related to the Center's research thrusts. We ensure that the research is conducted with a spirit of teamwork and inter-disciplinary input. This is achieved by joint faculty advisors on the doctoral thesis and/or thesis committee members from different departments and disciplines. To provide industrial perspectives on the students' training program, industrial personnel are often members of doctoral thesis committees. In addition, our industrial collaborators have also participated in course lectures, both for undergraduates and graduates. To further integrate our graduate students into the industrial environment, our students are part of our technology transfer activities to industry. In this capacity, the students obtain valuable perspectives on industrial research and development and, at the same time, act as the conduit to testbeds at industrial sites. Our graduate students also actively participate as teaching assistants (TAs) in the courses which are related to the Center's research thrusts. This training provides experience in teaching in case the students are planning careers in academia.

Through the efforts of the BPEC, the Interdepartmental Biotechnology Training Program successfully completed its 11th year. Twenty-four Training Faculty participate from the Departments of Biology, Chemistry, Chemical Engineering, and Mathematics, and the Division of Bioengineering and Environmental Health. This training grant is funded by NIH (NIGMS) with a total of 20 pre-doctoral trainees and recently received a new award for an additional five years.

The NIH Genome Training Grant was administratively transferred from the Whitehead Institute to the BPEC. The objective of the Genome Training Program continues to be the development of cross-disciplinary studies in informatics and functional genomics. However, additional emphasis on functional genomics technologies and toxicogenomics is supported by new faculty from the Media Arts and Sciences, EECS, and BEH. Additional changes to the program include the addition of new training faculty, new training courses, and a pared-down advisory committee. A total of 25 Training Faculty from the Departments of Biology, Chemical Engineering, Mathematics, Electrical Engineering and Computer Sciences, the Division of Bioengineering and Environmental Health (BEH), Laboratory of Computer Sciences, and the Media Arts and Sciences participate in the Training Program. There are currently 10 predoctoral training slots being requested for the next five years and three postdocs, due to an increase participation of training faculty and increased interest in genome sciences

An especially important and exciting development during this past year has been the introduction of a new Ph.D. program in Bioengineering (BE) within the Division of Bioengineering and Environmental Health (BEH), beginning in Fall 1999. The mission of BEH is to educate leaders, and generate and communicate new knowledge, at the interface between engineering and biology. The central premise of BEH is that the science of biology will be as important to technology and society in the next century as physics and chemistry have been in the one now ending. Therefore, engineers and scientists must be educated who: can apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions, or subjected to pathogens or toxins; and can apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries, or in non-health-

related industrial sectors such as agriculture, environment, materials, or manufacturing. That is, we must educate a new generation of people who can solve problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems. Hence, a key function of BEH is to create and support curricula in which biology and engineering are taught as synergistically as possible, and the new BE Ph.D. program is aimed directly toward accomplishing this function. The new program is designed to bring together engineering and biology in as fundamental a manner as possible. Stated broadly, it will educate students to use engineering principles in the analysis and manipulation of biological systems, to solve problems across a spectrum of important applications. Accordingly, the curriculum will emphasize fundamental concepts more than particular applications. By learning to advance both engineering and biological knowledge, it is anticipated that the graduates will be well positioned to contribute to many areas of research in both academic and industrial settings.

In this initial year of its operation, 1999–2000, 11 outstanding 1st-year Bioengineering graduate students were brought in; our goal for the foreseeable future is to recruit ~10–15 new graduate students per year. The typical entering students hold a B.S. (or M.S.) degree in an engineering discipline (typically Biomedical, Chemical, Electrical, Mechanical, Materials Science, or Computer Science). During their first year the students pursue a unified core curriculum, in which approaches from the various engineering disciplines will be used to examine biological materials and organisms over a wide range of length and time scales. The core curriculum, which will consist largely of subjects not offered previously at MIT, will be the hallmark of the new program. The program will have its own Ph.D. qualifying exams, the written part of which will be based on the core curriculum. To enhance depth and breadth, the core subjects will be supplemented by electives in the biological sciences and engineering. A student's research will ordinarily begin near the end of the first year, leading after approximately five years of total residence to a completed Ph.D. thesis.

Leadership in The Field and Involvement with Others

There are many indicators noting how BPEC is recognized and respected as a national center to the professional communities. One measure on the outreach and leadership of the ERC faculty is the invited presentations to the various biotechnology communities. The 11 faculty members in the BPEC during 1999–2000 participated in the following categories:

Number of seminars at universities	=	44
Number of seminars at industry	=	25
Number of presentation at national and international conferences and symposium	=	34
Number of workshop/short course participation	=	91

A second indicator of BPEC's faculty leadership and achievements is the honors, awards and professional leadership services bestowed during fiscal 2000. A significant number of the BPEC faculty have been recognized by invited distinguished lectureships across the country, major awards and prizes, and fellow election in professional societies. It is our opinion the data presented above demonstrates the Center's outreach and leadership in the field of biotechnology.

An indicator of outreach from BPEC is its collaborative efforts with other universities in education and/or research. In education, we have had invited guest lecturers in our graduate and undergraduate courses from not only other universities but also from biomedical and biotechnology companies, including representatives from CytoTherapeutics, Dyax, Advanced Tissue Sciences, Genzyme, Entelos, and Circe Biomedical. In research, we sponsored seminar series in both 'Bioinformatics' and 'Stem Cells' with invited speakers again from other universities and from industry. Research collaborations of BPEC faculty with colleagues at other universities are numerous, including projects with investigators at Dartmouth Medical School, Brown University Medical School, Harvard Medical School, University of Delaware, Purdue University, Odense University (Denmark), University of Copenhagen (Denmark), and University of Toronto, not exhaustively.

BPEC has entered into a partnership with the bioengineering-related ERCs at Georgia Tech and University of Washington to co-sponsor an annual Workshop; in February 2000 it was held at Hilton Head, SC, and was entitled 'Workshop in Computational Modeling in Biology and Physiology.' This partnership is fostering positive interactions among these three bioengineering-related ERCs, and indeed MIT and Georgia Tech are developing plans to identify new collaborative research projects under joint ERC auspices.

On the industrial interactions front, we are exceedingly pleased to officially have a new Therapeutic Gene Biotechnology Industrial Consortium in place, with ten companies who have participated enthusiastically in our October 1999 Fall Retreat as well as our April 2000 Spring Board Meeting. This Consortium is largely the result of extraordinarily effective work by our Industrial Liaison, Dr. Matthew Croughan, a BPEC alumnus and former Senior Scientist in cell culture technology at Genentech. Furthermore, we have added Jean-Francois Hamel in the position of Assistant Industrial Liaison and Laboratory Supervisor, to focus on student and facilities interactions with industry as well as day-to-day operation of the core laboratory.

Accordingly, a plan for an intermediate-level consortium in therapeutic gene biotechnology was written and distributed to the TGB IAB members for their review. Many responded favorably and soon sent in signed consortium agreement forms and fees. Thus, we now have a substantial Industrial Consortium in our new TGB Thrust, and have held a first meeting of our Industrial Consortium Advisory Board (ICAB), in April 2000. The ICAB's conducted analysis of the Center was gratifyingly favorable—clearly, our new industry partners view BPEC as having regained a sound footing in its new strategic direction.

Regarding infrastructure advances, we have reconfigured our BPEC core laboratory space in MIT Building 16 to increase the coherence of BPEC-related research activity, and have consequently observed an enhancement of social as well as technical interactions among our students, postdoctoral associates, and research staff.

FUTURE GOALS FOR FISCAL YEAR 2001

BPEC's objectives remain to impact the education of undergraduate students, graduate students, and industrial personnel in their ability to work at the engineering/biology interface on important problems in biotechnology. In order to carry out these objectives, BPEC plans to continue its outreach involvement in education through the BEH, NIH Training Grants, UROP and NSF REU programs, and industrial internships. In addition, through collaborative and team efforts continue its research focus in gene therapeutics. The goal for BPEC's Industrial Consortium Advisory Board is to expand its membership to 15 firms in the coming year.

PERSONNEL CHANGES

Four new investigators were added to BPEC research teams. Three serve as lead investigators on particular projects: in the Targeted Delivery Vehicle Sub-Thrust: Dr. K. Dane Wittrup, Professor of Chemical Engineering and Bioengineering at MIT; Dr. Jack Wands, Professor of Medicine and Director of the Liver Research Center at Brown University Medical School; and, Dr. Shuguang Zhang, Principal Research Scientist in the Center for Biomedical Engineering at MIT. Wittrup and Wands bring expertise in human therapeutic applications focused on antibody-targeted adenoviral vectors for liver cancer therapy, and Zhang adds expertise in novel, peptide-based synthetic delivery vehicles to complement our ongoing organic polymer-based synthetic vehicle work directed by Robert Langer. Dr. Ihor Lemischka, Professor of Biology at Princeton University, has joined as a collaborator on a project directed by Harvey Lodish in the Stem Cell Vehicle Sub-Thrust, providing additional expertise on stromal factors that regulate hematopoietic stem cell function.

Mr. Jean-Francois Hamel transferred 25% time from the Department of Chemical Engineering to serve in two capacities: Core Facility Lab Manager and the Associate Industrial Liaison.

Ms. Patricia Reilly transferred 100% time from the Department of Biology to assume of the role of Program Manager for the DuPont MIT Alliance.

More information about this center can be found on the World Wide Web at http://web.mit.edu/bpec/.

Audrey Jones Childs

CENTER FOR INNOVATION IN PRODUCT DEVELOPMENT

The Center for Innovation in Product Development (CIPD) was established in 1996 as a National Science Foundation Engineering Research Center. Our interdepartmental research program involves MIT's School of Engineering and Sloan School of Management, and is funded now by the NSF and CIPD's 10 industrial partners. Our budget of $3.2 million for AY 2000–01 will support 25 faculty and 60 graduate students in their research. Under the guidance of co-directors Prof. Steven Eppinger and Prof. Maurice Holmes, and executive director Ellen Williams, CIPD strives to advance the theory and practice of product development.

CIPD links representatives from academia, industry, and government who share our dynamic vision of the future of product development: new products will be developed by just-in-time collaborations of globally-distributed teams linked seamlessly by web-based tools and processes. These collaborations will be formed by means of a "services marketplace" where lead firms will find the world's best "knowledge purveyors"—suppliers of information, components, and support services.

Our mission is to lay the conceptual groundwork for, and contribute core components to, a product development (PD) infrastructure that will help companies succeed in the services marketplace we envision. In pursuing this mission, we use industrial sites as our laboratories. Working with engineers and managers in product development environments, we extend our fundamental understanding of the PD process, and also provide innovative improvements to current practice. To that end, we develop and implement programs of research, education, and outreach.

RESEARCH PROGRAMS

Effective June 1, 2000, CIPD reorganized its four research thrusts into seven Research Initiatives. Our new initiatives and associated lead faculty are:

- Virtual Customer (VC): Prof. John Hauser
- Distributed Object Modeling Environment (DOME): Prof. David Wallace
- Incentives and Boundaries (IB): Prof. Rebecca Henderson
- Implementation Dynamics (ID): Prof. Nelson Repenning
- Information Flow Modeling (IFM): Dr. Daniel Whitney
- Platform Architectures (PA): Dr. Kevin Otto
- Integration Lab (PDIL): Prof. Maurice Holmes

We now summarize the history, status, and development plans for each initiative.

Virtual Customer

Advances in on-line information collection now make it possible to engineer systems that make maximum use of customer input. In the past two years, our research in this area has expanded from one to five interconnected projects. In spring 2001 we will evaluate each of them, and decide which combination is most likely to shape the ways that companies gather information from customers and distribute it to their engineers. We will begin to link a subset of these projects to the DOME project (see below).

Distributed Object Modeling Environment

This CIPD centerpiece is our largest initiative, and support for it has grown steadily in the last two years. Early in 2001, Project DOME will undergo a thorough review as we begin to develop the next generation of DOME architecture. In particular, we will expand the links to research conducted on understanding of organizational structures. Thus, we will support the integration of product development services that are available in a distributed PD services marketplace.

Incentives and Boundaries

Real people in real organizations act in their own best interests. Incentives within the organization communicate the company's fundamental intentions to people throughout the organization and beyond. In the services marketplace that we envision, incentives must cross the boundaries of the organization and reach the virtual enterprises beyond it. We will continue our commitment to this initiative at existing levels for the next two years, with a greater emphasis on evaluation and industrial testing of our methods.

Implementation Dynamics
We are developing a methodology for estimating the capacity of a product development system. We want to complement many of the advances in the theory of process design with a better theory of process improvement and implementation. Such a theory should both explain high rates of failure and provide the basis for developing an implementation methodology that will prevent such failures in the future. Results this past year include the completion of an expanded model of self-reinforcing dynamics in product development processes, the prototype of a management flight simulator based on that model, a case study concerning the impact of a PD improvement on a specific product portfolio, a sensitivity analysis, and an Internet-based learning environment.

Information Flow Modeling
We are developing advanced methods for the management of knowledge used in the engineering design process. These methods are based on the techniques of information flow modeling through the application of design structure matrices. The resulting visual representations of development activities serve as maps for understanding and improving the PD process.

Platform Architectures
CIPD is defining a theory of platform architecture. In it, we seek to match customer needs with function, match function with technology, transform technology into a set of integrated design modules, and screen and optimize these modules against a set of portfolio architecture design principles. This work is critical to our defining successful product families, so we hope to significantly increase the size of this initiative in coming years.

Integration Lab
CIPD established the Product Development Integration Laboratory for three compelling reasons: to develop and foster intellectual ties with engineers and scientists from industry; to facilitate a two-way flow of ideas leading to participation in the Center's research and education programs; and to assist in the transfer of knowledge and technological advances to industry. Equipped with $150,000 of state-of-the-art displays and video conferencing equipment, the PDIL can demonstrate the feasibility of Web-based product development systems that integrate research from CIPD with commercial enterprises and other universities. In addition, the lab makes new technologies available for undergraduate, graduate, and professional education. PDIL officially opened in CIPD's newly-renovated facilities in Building 5 during April of 2000.

The reorganization of our research into the programs outlined above is a result of growth, due largely to our being an organization whose function between academia and industry is integration. We naturally encourage maximum integration *within* research programs, but find over time that integration often occurs *between* programs. This evolution happens not only because many faculty work within more than one program, but more importantly because our most interesting and challenging research occurs at the interface between programs.

OTHER RESEARCH HIGHLIGHTS
New Industry Partners
In the fall of 1999, CIPD welcomed three new partners as sponsors: CVC Incorporated, IDe Incorporated, and Product Genesis Incorporated.

- CVC (Control Vacuum Corporation) provides semiconductor processing solutions to the data storage industry. Founded in 1934 as the experimental vacuum group of Eastman Kodak, CVC was acquired by Veeco in March 2000, and provides equipment for the delivery of thin film processes used in recording head and semiconductor manufacturing.
- IDe (Integrated Development Enterprises) focuses on integrated business solutions for enterprise-wide product development. Founded in 1997, IDe develops and markets a suite of software applications that allows a corporation to align its product portfolios with its global business strategy.
- Product Genesis, founded in 1986, provides complete product development services from initial concept to market ready product. Product Genesis' unified approach to product development combines mechanical, electrical, and software engineering with industrial design and human factors expertise.

These three new companies joined Ford, General Motors, IBM, ITT Industries, Polaroid, the US Navy, and Xerox as CIPD's industrial partners.

EDUCATIONAL PROGRAMS FOR WORKING PROFESSIONALS

CIPD is an interdisciplinary program between the School of Engineering and the School of Management. Our educational mission is to promote product development as part of the core engineering curriculum both at MIT and throughout the United States. Students' course experiences should address the interplay between the technical, social, and system elements of product development, and prepare them for work in the globally distributed services marketplace. Our PD educational programs target three communities: working professionals, graduate students, and undergraduates.

SDM Product Development Track

The SDM Product Development Track was created in collaboration with MIT's System Design and Management (SDM) program. This two-year degree program targets mid-career engineering professionals who are potential leaders in product development. Students continue work for their employers at least half-time while pursuing their degree through an innovative educational structure: courses are broadcast to the students' company sites. Several times per year, students visit MIT to participate in special PD course modules, and for one semester in their program, students study on campus. At course completion, students receive an MIT degree in Engineering and Management. The first class of SDM PD candidates began in January of 1998, and they completed the program in December of 1999. To date, 187 students from 31 companies have joined this track.

PD21

CIPD began disseminating the SDM product development curriculum in 1998: we collaborated with the University of Detroit Mercy (UDM) and the Rochester Institute of Technology (RIT) to create and implement the program now called PD21, the Education Consortium for Product Development Leadership in the 21st Century. Guided by our industrial sponsors Xerox and Ford, the schools copy MIT's core PD curriculum, but emphasize project and case study work relevant in their geographic areas (optics in Rochester and automobiles in Detroit). The first PD21 students began their programs at UDM and at RIT in January 1999, and will graduate in December 2000. In addition, the Naval Postgraduate School became a member of the PD21 consortium in May 2000, and students will enter its program in September.

Executive Education Courses

CIPD faculty created and are teaching a full suite of short courses as non-degree programs. These industrial mini-courses (well over 20 this year) are offered throughout the year through MIT's office of summer professional programs and through Sloan's office of special executive programs. In addition, SDM faculty offer 12 courses by distance learning through the SDM Product Development Track (see above).

EDUCATIONAL PROGRAMS FOR GRADUATE STUDENTS

CIPD created the course "Product Design and Development" to bring together engineering and management students in the study of product development processes. Students identify market opportunities, design new products, prototype the products, and develop appropriate business models. The course is offered by both the Engineering and Management Schools (2.739 and 15.783), and over 80 students attended the class in the spring of 2000. We are planning the first workshop for professionals who want to be associated with this course, and will present the workshop in March of 2001 in conjunction with the annual meeting of the NCIIA (National Collegiate Inventors and Innovators Alliance).

In 1999, the center supported the construction of a web site based on the course above. The website provides an extensive set of resources for students and support materials for faculty teaching comparable courses at other institutions. The site is organized around the book *Product Design and Development* as it is taught at MIT, and can be found at http://www.ulrich-eppinger.net/.

CIPD collaborated on the design of a semester-long MBA course based on an integrated theory of the firm. Entitled "Integrative Course in Organizational Theory" (15.903); the course incorporates the latest (often CIPD-funded) research while analyzing insights from organizational theory and economics. The course will be taught for the first time in the fall of 2000.

In June 2000, MIT awarded 17 Master's degrees and 5 Ph.D. degrees to students funded by CIPD.

In the Fall of 1999, CIPD students formed the Student Leadership Council (SLC). The Council facilitates communication between research groups, and promotes greater project integration by hosting weekly lunch discussions, social trips, and workshops. The SLC is becoming increasingly responsive to and responsible for its membership. For example, two SLC leaders attended the NSF-ERC annual meeting in November 1999, networked with other students for ideas about SLCs, and surveyed CIPD students for pressing issues to address. In the coming year, the SLC will play a greater role in planning Center student activities and increasing its membership.

EDUCATIONAL PROGRAMS FOR UNDERGRADUATE STUDENTS

CIPD supported Professor Earll Murman in the development of an FAS seminar, "Introduction to Product Development." The seminar introduces freshman engineering students to product development with a project they undertake alongside PD professionals (the course is co-taught by an MIT faculty member and a PD leader from industry). We are now working with Professor Murman to design an instructor's guide, which will be available in the fall of 2000. We expect to launch the course in institutions outside MIT in 2002.

The National Science Foundation awarded CIPD a grant to provide equipment for undergraduate lab facilities. Undergraduates can now develop and test prototype products as part of PD classes and student-defined activities in several engineering departments. In the summer of 1999, the first shipment of equipment was installed, and became available in the fall for use by more than 150 undergraduates working on PD projects. The remainder of the equipment will be installed in the summer of 2000 in a new laboratory space in the Aero/Astro complex that MIT elected to construct. The facility will be available by fall 2000.

OUTREACH PROGRAMS

The center's outreach activities aim to provide experiences in product development research and practice for minority students, women, and their teachers; and to provide life-long learning experiences for business professionals.

Project FAIHM

CIPD joined with MIT's Edgerton Center and Hewlett-Packard to build a program that engages young women and their high school teacher-advisors in FIRST Robotics Competitions. FIRST (For Inspiration and Recognition of Science and Technology) is a national program that organizes an annual competition for high school students and their academic and industrial mentors. Teams of students from across the country partner with local industrial supporters to design and construct a computer controlled machine that will accomplish a competitive task. In 1999–2000, 378 teams of some 17,000 high school students entered the competition. The teams competed in regional tournaments and a national competition at EPCOT in Orlando.

The program created by our coalition is called FAIHM (pronounced "fame," an acronym derived from the coalition's members—FIRST, Autodesk, Institute for Women and Technology, Hewlett Packard, and MIT). The program aims to give teacher-advisors new educational tools and insights, and to encourage young women to become leaders in the design of technology.

In November of 1999, the program's pilot year, we invited nine student-teacher teams from schools in the eastern United States to MIT for a two-day workshop. Hewlett-Packard provided the team members with computers and test and measurement equipment. The workshop included sessions on the use of equipment and software (provided by Hewlett-Packard and Autodesk), and an overview of product development and design. Each of the nine student-teacher teams also received the hardware necessary to produce an educational CD that was showcased at the FIRST Regional Competitions and the National Championship at EPCOT. The CD will also be presented at the Women in Science and Technology Forum planned at FIRST Place in Manchester, NH, during the Spring of 2000. The CDs will also be available to assist future FIRST Robotics teams.

As we evaluate our role in the program, we are considering expanding our involvement to include more high school FIRST teams.

Minority Introduction to Engineering, Entrepreneurship, and Science (MITE^{2}S)

During the coming year, CIPD will consider partnering with MITE^{2}S to increase the program's emphasis on product development. MITE^{2}S is a rigorous six-week residential summer program at MIT where high school juniors study calculus, chemistry/biochemistry, engineering design, entrepreneurship, physics, and writing. The program is open

to promising U.S. citizens or permanent residents who are Native American, Hispanic American, or African American.

DOME Open House
In September 1999, this half-day event was hosted by Ford in Dearborn, Michigan, and consisted of presentations by the Ford and MIT teams that conducted a DOME pilot during the previous summer. Fifty-five persons attended from Boeing, Ford, GM, IBM, ITT Industries, Kodak, Navy, Polaroid, and SDRC. This open house was also the initial meeting to form a DOME Working Group.

Product Development Warrior 2000
Hosted by the Naval Undersea Warfare Center at Newport, Rhode Island, in December 1999, this event joined CIPD with the National Center for Manufacturing Sciences (NCMS), Technologies for Enterprise-Wide Engineering, and partner and affiliated companies for a two-day business war game on product development. Forty-five persons attended from the Air Force, Army, Boeing, Center for Quality Management, Ford, Kodak, Product Genesis, and SDRC. On the final day, the DOME Working Group met to define its charter.

Workshop: DSM for Researchers and Practitioners
In September 1999, CIPD cosponsored this workshop on DSM (Design Structure Matrix) along with the Lean Aerospace Initiative, Leaders for Manufacturing, and Ford Motor Company. Twenty papers were presented at this highly interactive gathering, which was attended by 50 researchers and practitioners from ABB, Boeing, Fiat, Ford, Lockheed-Martin, Saab, UDM, University of Texas, Visteon, and VTT Building Technologies.

Workshop: Organizing for Innovation
In November 1999, CIPD hosted this workshop for senior general and technical executives involved in the development, management, or marketing of technology and products. Faculty and member companies presented work to twenty-five attendees from General Motors, IBM, IDe, ITT Industries, Navy, Polaroid, Product Genesis, and Xerox.

NSF FUNDING

In April 2000, the National Science Foundation conducted its Third Year Review and Site Visit to determine the degree to which it would continue to support CIPD. The NSF was quite positive in many aspects of its review, stating in its site report:

> The expected value of the outcomes and the impacts of [CIPD] if funding is continued is extremely large. There is no other set of projects like this in the U.S. There is ground-breaking work being done that will favorably impact the way product development is accomplished in the upcoming years. There is both a short and long term payback to the investment.

However, the NSF elected not to extend funding beyond January 2002. As a result of the NSF's decision, CIPD is reevaluating its strategy. While funded by the NSF, we were limited to partnering with companies within the United States. CIPD is actively seeking new partnerships, and in 1999 hosted visits by nearly 50 companies from around the world. They included such well-known firms as Alcoa Aluminum, British Telecom, Corning, Mattel, Mitsubishi, Nissan, Saab, Singapore Airlines, and TRW. Our goals for the coming years are to recruit partners in industry sectors that complement our existing membership. Our current partners operate mainly in the industrial, capital goods, technology hardware and equipment sectors, and to complement them we will target the telecommunications, aerospace, software, and information technology sectors.

OTHER RECENT AND UPCOMING EVENTS

- January 2000. Fourth Annual Variation Risk Management/Key Characteristics Symposium.
- March 2000. Enterprise Learning Research Conference: the first in a series of conferences on this topic.
- May 2000. Meeting of the DOME Working Group: participants included representatives from Boeing, Ford, MSC, United Technologies, US Air Force, US Navy, and others.
- August 2000. Industry/NAVY R&D Partnership Conference.
- September 2000. Second International Design Structure Matrix Workshop.
- October 2000. CIPD Fall Research Review: this first of two reviews will present the latest theoretical and applied research conducted at CIPD. Intended for senior executives and managers involved in PD activities, it will combine presentations about research projects with network sessions for industry partners, CIPD faculty,

and students. The review will focus on three of CIPD's core initiatives: Information Flow Modeling (IFM), Implementation Dynamics (ID), and Distributed Object Modeling Environment (DOME).

- October 2000. CIPD Executive Council Meeting: this meeting will review the summer's activities and plan our research over the next year.
- December 2000. Sloan Executive Education: "Managing Complex Product Development Projects."
- December 2000. Sloan Executive Education: "Developing and Managing a Successful Technology and Product Strategy."
- February 2001. CIPD Spring Research Review: this review will complement the Fall Research Review by focusing on CIPD's remaining core initiatives: Virtual Customer (VC), Incentives and Boundaries (IB), Platform Architectures (PA), and the Product Development Integration Lab (PDIL).
- March 2001. Sloan Executive Education: Managing Complex Product Development Projects
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PERSONNEL CHANGES

This past year has been one of significant growth and change for the Center. Most notably, Steven D. Eppinger joined Professor Maurice Holmes as co-director of CIPD, effective June 1, 2000. Professor Eppinger, General Motors LFM Associate Professor of Management Science and Engineering Systems, holds a joint appointment in the Sloan School and the School of Engineering. He received his bachelor's, master's, and doctoral degrees from MIT in mechanical engineering.

Also in June, Professors Warren Seering and John Hauser stepped down as, respectively, CIPD's co-director and director of research. Professors Seering and Hauser will return to their teaching and research duties as faculty members, and will continue their affiliation with the Center as leaders of new initiatives within the research program.

The center hired Ellen Williams as Executive Director in September 1999. Before joining CIPD, Ms. Williams consulted for high profile companies in the high technology, public policy, and health care sectors.

The center also hired Su Chung as Manager of Finance and Administration, Bill Finch as Research Scientist, Kim Anton and Nils Nordal as Administrative Assistants, and Juliet Kapsis as a Senior Staff Assistant.

More information about this center can be found on the World Wide Web at http://web.mit.edu/cipd/.

Ellen Williams

CENTER FOR TECHNOLOGY, POLICY, AND INDUSTRIAL DEVELOPMENT

MIT faculty and researchers at the Center for Technology, Policy, and Industrial Development (CTPID) work collaboratively with over 65 sponsoring corporations and government agencies to develop new knowledge and technological strategies that support global economic growth and advance policies that preserve the environment and benefit society at large.

CTPID's ten interdisciplinary research programs focus on contemporary industrial problems—such as how to build safe, affordable, and environmentally friendly automobiles—that span social, natural, and technological interests. Established in 1985, CTPID's programs, which generated nearly $8 million in research funding in FY2000, address industrial issues in the aerospace, automotive, business and environment, materials systems, mobility, telecommunications, and technology and law sectors.

Over 50 faculty and researchers at MIT's schools of engineering, management, humanities, and social sciences are affiliated with the center and a hundred more scholars at MIT and other prestigious universities participate in research projects. Faculty and CTPID researchers lead these programs: the Cooperative Mobility Program (CMP); Ford/MIT Collaboration (administered by CTPID); International Motor Vehicle Program (IMVP); Labor Aerospace Research Agenda (LARA); Lean Aerospace Initiative (LAI); Lean Sustainment Initiative (LSI); Materials Systems Laboratory (MSL); Research Program on Communications Policy (RPCP); Technology, Business, and Environment Program (TBE); and Technology and Law Program (T&L).

HIGHLIGHTS 1999–2000

Two major initiatives launched in 1999–2000 focused CTPID researchers on strategic opportunities related to the Internet and communicated the center's accomplishments to broader audiences both within MIT and outside.

Planning began this year for the conference entitled "The Third Wave: Industry Opportunities for the Internet-Enabled Future," A Multidisciplinary and Cross-Industry Exploration of How Information Technologies and the Internet Are Challenging—And Changing—the Aerospace, Transportation, Communications, and Resources Industries. The conference was spurred, in part, by the intention to introduce sponsors and prospective sponsors to the full scope of CTPID research opportunities and, in part, by program innovations such as the International Motor Vehicle Program's new Global eAutomotive Program. Scheduled for Nov. 8–9, 2000, the conference will present keynotes on the impact of the Internet on the automotive industry and on the future of the Internet, and each program will describe recent research and how information technologies are changing their research sectors. The conference is co-sponsored with MIT's Office of Corporate Relations.

A major communications initiative began this year to more effectively convey the scope of CTPID research both within the center, within MIT, and to the public. The center established an Office of Communications that accomplished these goals:

- Published a 24-page brochure that articulated the intellectual focus and individual accomplishments of center programs
- Redesigned the CTPID web site to focus on news and the breadth of center programs
- Invented the newsletter *IMPACT: Emerging Work from CTPID*. The three issues included interviews with academic leaders, speeches by corporate leaders, program news, researcher profiles, and new publications
- Initiated CTPID Community Lunches that fostered intellectual conversation among diverse programs. The four events featured talks on recent research by the directors of the Lean Aerospace Initiative; Research Program on Communications Policy; Technology, Business, and Environment Program; and the International Motor Vehicle Program
- Publicized two MIT Industry Leaders in Technology and Management Lectures featuring Eastman Kodak's Board Chairman George M. C. Fisher and Lucent Technologies Chairman and CEO Richard A. McGinn via internal publicity and articles in *Tech Talk*

CTPID plays a key part in the Engineering Systems Division's mission and mandate by helping to define ESD's research agenda and contributing to its development. Both CTPID's research programs and 25-year-old graduate program are now part of ESD. The master's Technology and Policy Program and the doctoral Technology, Management, and Policy Program enrolled 141 students in 1999–2000; 39 students earned SM degrees and four earned PhDs.

The Labor Aerospace Research Agenda completed its first year, co-directed by Thomas Kochan, George Maverick Bunker Professor of Management, and Senior Research Scientist Joel Cutcher-Gershenfeld.

Debbie Nightingale, Professor of the Practice of Aerospace Engineering, initiated a new program to develop the LAI Lean Enterprise Self Assessment Tool (LESAT).) The prototype Enterprise Level module is designed to facilitate multiple business and government processes ranging from financial analysis control to managing technology innovation.

Motorola, Inc. became the 10th member company supporting the work of RPCP's Internet and Telecoms Convergence. Cisco Systems is a new sponsor of the Materials Systems Lab.

New books
Car Launch: The Human Side of Managing Change, by Ford-MIT Collaboration Executive Director George Roth et al. Oxford University Press Learning History Library, 1999.

Product Design and Development, 2nd edition, by Steven D. Eppinger, Ford-MIT, et al, Irwin/McGraw-Hill, 2000.

Competition, Regulation, and Convergence: Current Trends in Telecommunications Policy Research, edited by Sharon Eisner Gillett, RPCP Executive Director, et al. Lawrence Erbaum Associates, 1999.

Oil Change: Perspectives on Corporate Transformation, by George Roth, Ford-MIT, et al. Oxford University Learning History Library, 1999.

Introduction to Transportation Systems, by Joseph Sussman, CMP,
Artech House Publishers, 2000.

Publication Award: Daniel Whitney and Krish Mantripragada, who earned a PhD in 1998 after working with Whitney on the Agile Manufacturing Project, won the IEEE Transactions on Robotics and Automation Best Paper Award for 1999.

New Visiting Scholars
Christopher Boutleiller, professor of finance at Reims Management School, France, and Catholic University of Louvain, Belgium, was a visiting scholarly studying intangible asset assessment in the services industry.

Ki-Chan Kim, director of the Institute of Industry Management and Associate Professor of Management at the Catholic University of Korea, joined IMVP to study aspects of automotive supply chains.

Fred Stahl, an aerospace executive and Air Force consultant, and Jeffrey Bentley, manager of business research at Textron Systems, Inc., were LAI visiting scholars.

Salvator Gerbino, an engineering professor at the University of Naples, and Stefan Bungert, a graduate student at the Technical University of Berlin, worked with Senior Research Scientist Daniel Whitney.

Lee McKnight, director of the Edward R. Murrow Center at Tufts University, and Hyun-Dae Cho, senior researcher at the Korean Institute of Science and Technology, held ongoing appointments with RPCP and TPP, respectively.

Future Plans
"The Third Wave: Industry Opportunities for the Internet-Enabled Future" conference, scheduled Nov. 8–9, 2000, and cosponsored by CTPID and the Office for Corporate Relations, is expected to draw 150–200 corporate and government sponsors and prospective sponsors.

Charley Fine will become director of the IMVP program July 1, 2000. He will co-chair IMVP's new Global eAutomotive Program with Professor John Paul MacDuffie of the Wharton School, University of Pennsylvania.

Michael C. Ruettgers, CEO of EMC Corporation, is scheduled to speak October 11 in the jointly sponsored Leaders in Technology and Management Lecture series.

Personnel Changes
Ford executive Chris Magee, who holds a PhD and a MBA, came to MIT as executive director of the Ford/MIT Strategic Technical Partnership.

Jennifer Nash, Associate TBE Director since 1996, was appointed acting director.

William Lehr, who served as RPCP acting director August–March, was named associate director.

Fred Stahl, an aerospace executive, was appointed as LAI stakeholder co-director.

Joel Cutcher-Gershenfeld, LARA co-director, was named Senior Research Scientist.

Professor Richard de Neufville retired as chairman of the Technology and Policy master's program after 25 years. Aero/Astro Professor Dan Hastings was named TPP co-director.

Nancy DuVergne Smith, a communications and web consultant, was appointed communications director.

Tributes
CTPID hosted a retirement dinner for John Ehrenfeld, who retired as Technology, Business, and Environment Program director in April. He will spend next year teaching at the Technical University of Delft, the Netherlands. Ehrenfeld won the 1999 Lifetime Achievement Award give by World Resources Institute and the Initiative for Social Innovation through Business, a program of the Aspen Institute.

Fred Moavenzadeh, Professor of Engineering Systems and Civil and Environmental Engineering, is center director; Patricia Vargas is assistant director. CTPID's 17-person faculty council, which provides intellectual oversight and liaison with academic units across MIT, includes leaders from the School of Engineering, the Sloan School of Management, Lincoln Laboratory, and MIT's Office of Corporate Relations.

For more information, visit http://web.mit.edu/ctpid/www/.

Cooperative Mobility Program
The Cooperative Mobility Program (CMP) brings together transportation scholars from MIT and other universities with private sector specialists and corporate sponsors to explore current and future issues of worldwide mobility. CMP proposes a new vision: a sustainable multimodal transportation system that will provide the mobility necessary to foster global economic development compatible with social needs and environmental concerns.

CMP is grounded in empirical research on travel behavior, technological approaches, and public policies that affect mobility in both developed and developing countries. It compiles an annual Mobility Observatory that tracks innovative developments in transportation policy, management, and technology.

Among other research projects conducted in the past year, CMP researchers and graduate students studied the impacts of transportation on air pollution in Mexico City; worked on forecasts of worldwide demand for mobility; assessed the implications of transportation trends for controlling greenhouse gas emissions; and studied emerging mobility trends in China.

Current planning for the coming year focuses on preparing a volume of essays reporting the program's academic research for a general audience and a possible major initiative on worldwide connections between mobility and environmental protection.

FORD/MIT COLLABORATION
In an innovative program, the Ford Motor Company has engaged the Institute in addressing an array of 21st century challenges confronting the automotive manufacturer. The multimillion dollar collaboration, begun in 1997, focuses on three research areas: virtual engineering, virtual education, and the environment. Initial priorities include the study of engineering design and educational environments of the future as well as seed funding for a major MIT-directed consortium to address global environmental challenges. One goal of the collaboration is the development of mechanisms for effective, long-term industry/university partnerships.

CTPID administers the overall grant and is the home to several of the Ford/MIT Collaboration projects. As part of Ford's Virtual Engineering research, CTPID Senior Research Scientist Daniel Whitney is leading a project on Assembly Advisor, incorporating assembly information in computer-aided design systems. He is also involved, with Professor Steven Eppinger, in a project called Information-Based Product Development that explores appropriate information technology tools for synthesizing complex information in product development programs. Lotte Bailyn, the T Wilson (Class of 1953) professor of management, leads the Engineering Careers Project. Janice Klein, senior lecturer at the Sloan School of Management, heads research on Virtual Teams. George Roth, executive director of the program, also leads a research effort on the organizational changes implied by industry partnerships at MIT.

As a partner in this Institute-wide initiative, CTPID supports over a dozen projects and twenty researchers working on Ford-MIT projects. MIT faculty involved in the Ford/MIT Collaboration use conferences, videoconferences, web sites, and virtual forums to communicate the results of this work to both Ford and the public.

George Roth is the executive director. For more information, visit the Ford/MIT Collaboration web site http://ford-mit.mit.edu/.

INTERNATIONAL MOTOR VEHICLE PROGRAM

IMVP, the largest international research group studying and reporting on the automobile industry and its global milieu, is launching a new Global eAutomotive Program directed at understanding the impact of information technologies on the auto industry.

Innovations in the Internet, electronic business practices, and consumer expectations are leading to a transformation that challenges every point of the value chain. And this new challenge puts consumer choice at the heart of each transaction. The Global eAutomotive Program focuses on how evolving engineering trends, business practices, and information technology will sustain and grow some companies while threatening to make others obsolete. eAutomotive's new research projects are designed to encourage a new way to think about making things, through the neutral brokerage of independent thinking.

Since 1980, IMVP has provided an unbiased, detailed, and integrated view of the dynamics of the worldwide automotive industry and its important drivers. IMVP and its predecessor, the Future of the Automobile program, have received funding from the Sloan Foundation, automakers worldwide, and their suppliers since the late '80s.

IMVP's International Assembly Plant Study explores issues related to quality, productivity, flexibility, and lean production in automotive assembly. Round One, led by John Krafcik and John Paul MacDuffie at MIT, led to the international best-seller, *The Machine that Changed the World* (1989), a book that unveiled the lean production system perfected in Japan. Round Two, conducted by MacDuffie and Frits Pil, enlarged the sample and revealed a pronounced trend converging on best practice worldwide.

Technology supply chains address these issues:

- assessing the present and future profitability and strategic leverage among the various sectors in the chain,
- designing the supply chain based on the strategic assessment, and
- assembling the capability to realize the organizational boundaries of choice and to manage within and across those boundaries.

The strengths of Lifecycle Analysis (LCA) as a strategic tool derive from roots in traditional process analysis and from the recognition that an action's effects include the entire range of consequences. IMVP has funded the development of a strategic lifecycle valuation methodology in conjunction with sponsors who are evaluating its use.

Professor Charles Fine is IMVP director. For more information, visit the IMVP website at http://web.mit.edu/ctpid/www/imvp/.

LABOR AEROSPACE RESEARCH AGENDA (LARA)

The Labor Aerospace Research Agenda (LARA) began in June 1998 with the belief that people are at the heart of new work systems—establishing stability and then driving continuous improvement. LARA was designed to further the understanding of this critical social dimension of what are termed lean principles in the aerospace industry. LARA operates under sponsorship and advisory input by the UAW and the IAM and it is affiliated with the Lean Aerospace Initiative. Funding is provided via the Manufacturing Technology initiative of the U.S. Air Force and other sources.

This year, the focus has been on the impact of instability on employment and new work practices in the aerospace industry. Specifically, we are examining three potential sources of instability—changes in technology, changes in markets, and changes in organizations. To better understand this issue, we have conducted five case studies in a mix of air frame, engine, and avionics facilities—spanning military and commercial sectors of the industry. LARA also completed a national random sample facility survey, with data collected from 196 separate aerospace facilities. Over 400 individual workers, engineers, and managers have also completed individual surveys on employment and instability issues.

The findings to date suggest that there are many innovative ways that individuals, facilities, and organizations attempt to mitigate the impact of instability. Still, the existing innovations are insufficient to effectively address the many sources of instability in this industry, which has direct measurable implications for individual employment and careers as well as for organizational performance. Based on these initial findings, LARA is continuing research on instability and broadening the focus in the coming year to explore industry-level institution building and issues centered on investment in intellectual capital.

A first step toward industry-level institution building occurred in January 2000, when leaders from labor, management, and government gathered in Washington to explore issues of high performance work systems, instability, and employment in the aerospace industry. The conference was co-sponsored by LARA and LAI. LARA also joins LAI in linking with related initiatives in England and Sweden, with an August 2000 calibration conference planned.

The project is led by co-principal investigators Joel Cutcher-Gershenfeld and Thomas Kochan. Susan Cass has joined the project as Project Manager, replacing Art Wheaton who has joined the labor education faculty at Cornell University. Project researchers Betty Barrett, Takashi Inaba, and Mike Parker continue work on the case studies and other products that are emerging from the research.

LEAN AEROSPACE INITIATIVE

LAI is a consortium-guided MIT research program managed under the auspices of the Center for Technology, Policy, and Industrial Development (CTPID) in collaboration with the Department of Aeronautics and Astronautics. Research is conducted by over a dozen faculty members from the Schools of Engineering and Management, graduate students from several MIT courses and graduate programs, and staff members of CTPID. LAI is an active partnership among 21 aerospace companies, 13 U.S. government agencies, labor representatives, and MIT. It also collaborates internationally with LARP (Lean Aerospace Research Program) at Linköping University and the UK LAI.

The initiative was formally launched in 1993 out of practicality and necessity as declining defense procurement budgets collided with military industrial overcapacity prompting a demand for "cheaper, faster, and better" products using a philosophy called lean. Lean means adding value by eliminating waste, being responsive to change, focusing on quality, and enhancing the effectiveness of the workforce. It was documented in the U.S. by researchers from MIT's International Motor Vehicle Program and in the book *The Machine That Changed The World.*

Since "lean" is much broader than production, integrative research that addresses the various stages of aerospace systems—planning, contracting, development, production, and operating—drives LAI's success and helps move its members forward in their lean journeys. This research examines Manufacturing Systems; Supplier Networks; Product Development; Acquisition; Organizations and People; and Test and Space Operations.

Through active collaboration and this focused team research, LAI delivers an evolving and expanded knowledge base. It's one that addresses complex products with relatively low volume production, the entire enterprise including product development and support, and the extended enterprise level including the government customer. Research rich products such as the Lean Enterprise Model (LEM) result, creating a foundation of reference tools for common awareness, language, and understanding of lean principles.

Research Results

Research progress and insights for the year include understanding production system design lessons from the automobile industry (Manufacturing Systems); modeling and analyzing cost, schedule, and performance in complex system product development (Product Development); building information systems to integrate the manufacturing supply chain (Supplier Networks); costs and cycle time implications of contractor and government policies during the development phase of major programs (Policy).

During the past year, LAI's Knowledge Deployment and Lean Enterprise product teams as well as the research teams acted as a catalysts for discussion and helped to infuse new ideas into the industry through thematic and topical workshops and conferences

LAI delivered major policy recommendations to the Department of Defense this past year. Recommendations were based on research from the "Economic Incentives for Production."

A Vision For The Future
Using "best life cycle value" as a beacon, LAI has identified five key themes for research in Phase III including: measuring value to the enterprise; time; organizations and people; knowledge and information infrastructure; and government as a lean customer and operator. LAI's plan is to address barriers to implementation in the transition to lean and to emphasize knowledge deployment.

Professor Earll Murman from the Department of Aeronautics and Astronautics and Professor Tom Allen from the Sloan School of Management are Co-Directors. Mr. Fred Stahl is the Stakeholder Co-Director for LAI.

More information on LAI can be found on the World Wide Web at http://web.mit.edu/lean/.

LEAN SUSTAINMENT INITIATIVE

LSI's mission is to enable fundamental transformation of the U.S. aerospace sustainment enterprise into a cost-effective, quality driven, timely, and responsive combat support system.

Highlights of the year are as follows:

- Developed a systems dynamics model of the USAF sustainment enterprise. The model contained an "as is" description of the upstream activities and the downstream activities. Dynamics involving cannibalization, workload, pipeline delay, ALC work flow, SMAG funding, and decision making are included in the model.
- Developed a metric tree for the F–16 aircraft PDM process and repair-on-demand process. Metric tree includes approximately 29 metric candidates, 6 covariate and 4 outcome candidates.
- Completed a survey of MRO companies to discern industry best sustainment practices.
- Developed a framework for defining, classifying, and implementing best sustainment practices (BSP). Identified over 2000 documented practices from previous and current research for potential implementation into the USF sustainment arena.
- Provided testimony to the U.S. Congress on JSF technology readiness and logistics.

Future Plans
Complete the development of the vehicle through which government and industry may support LSI research; and to expand the government stakeholder base to include the Navy, Army, and OSD.

LSI hired a new project coordinator, Tim Cathcart.

MATERIALS SYSTEMS LABORATORY

The Materials Systems Laboratory (MSL) is internationally recognized for its innovative work analyzing the competitive position of materials and the strategic implications of material choice. For nearly two decades, MSL has addressed the issues arising from materials choice in a range of applications, particularly those in the automotive, electronic, and aerospace industries, but with a recent emphasis on automotive applications. Currently, MSL is expanding its scope to once again address issues in electronic materials, with an initial focus on automotive electronics applications. This expansion will build upon MSL's past experience in the area of electronic materials processing as well as its recent experience in analyzing the competitive position of the proposed automotive dual voltage electrical system architectures.

MSL's work builds upon a unique combination of materials processing knowledge, engineering design practice, manufacturing process analysis, and environmental information to construct analytical tools for decision support and competitive analysis. To develop these tools, MSL has worked extensively to refine its extensions to classic engineering process modeling for the past two decades. Modeling elements have been married to elements of product design, material properties, and manufacturing assumptions to yield tools that can estimate the costs of product manufacture under a wide range of conditions. These tools analyze primary materials production, primary materials processing, component and subassembly manufacture, and end-of-life vehicle processing. In each case,

these tools estimate the costs of production as a function of processing technology, material flows, operating conditions, and energy and capital requirements.

MSL also has developed techniques for understanding how markets respond to the different combinations of engineering and economic performance available by using different materials. Further, MSL researchers analyze the environmental consequences of materials and process choice, incorporating the emerging life-cycle analysis paradigm. These tools make it possible, when used with economic and engineering assessments, to develop robust, credible, and defendable product strategies that take life-cycle information into account.

Richard Roth is the director of MSL. For more information visit the web site at http://web.mit.edu/ctpid/www/msl/.

RESEARCH PROGRAM ON COMMUNICATIONS POLICY

The Internet and Telecoms Convergence Consortium (ITC) is a sponsored research program at MIT consisting of industry and academic partners who collaborate on research into the technical, economic, strategic, and policy issues that arise from the convergence of telecommunications and the Internet. ITC is the principal research vehicle for the MIT Research Program on Communications Policy.

Highlights Of The Year

Internet Appliances and Applications: David Clark of MIT developed an architecture for the coming post-PC world and its impact on the Internet. John Wroclawski of MIT shared insights from his LCS project to develop an advanced mobile communications device.

Local Access and the Broadband Transition: William Lehr and Sharon Gillett of MIT collected and analyzed data on U.S. broadband deployments, demonstrating that population density and company identity were the strongest predictors of broadband service availability. Marvin Sirbu's team at Carnegie Mellon University modeled the cost of integrated services delivered over cable, DSL, and fixed wireless networks.

Global Internet Economics and Industry Structure: ITC co-sponsored two internationally attended workshops in this area: the Next Generation Internet Policy conference held in Brussels in September 1999, which brought together senior executives, policy-makers, and researchers to discuss the policy agenda; and the Internet Service Quality Economics workshop, held at MIT in December 1999, which brought together leading researchers from industry and academia to discuss new approaches to integrating economic and technical mechanisms to enable Quality of Service across the Internet. The effect of content delivery networks on industry structure was a particular focus of the January 2000 ITC members' meeting, including guest speakers from Akamai and Internap.

ITC Publications

Competition, Regulation and Convergence: Current Trends in Telecommunications Policy Research, Edited by Sharon Eisner Gillett and Ingo Vogelsang (Lawrence Erlbaum Associates, Mahwah NJ, 1999)

Gillett, Sharon Eisner and William Lehr. "Availability of Broadband Internet Access: Empirical Evidence" Presented at 27th Telecommunications Policy Research Conference, September, 1999.

Lanning, Steven, O'Donnell, Shawn, and Neuman, W. Russell. "A Taxonomy of Communications Demand." Paper presented at the 27th Telecommunications Policy Research Conference, September 1999.

Future Plans

Forthcoming books: David D. Clark, William H. Lehr and Lee W. McKnight, "Internet Telephony" (MIT Press)

Forthcoming papers: William Lehr and Lee McKnight, "The Next Generation of Consumer Broadband Access: Service Level Agreements, Bandwidth Brokers, and Exchanges" (28th TPRC, Sept. 2000) Sharon Gillett, William Lehr, John Wroclawski and David Clark, "Taxonomy of Internet Appliances" (28th TPRC, Sept. 2000)

Personnel Changes

Dr. William Lehr, an economist, joined the staff of RPCP as Research Associate and ITC Associate Director. Dr. Lehr studies the economics of Internet infrastructure provisioning, especially with regard to industry structure and business strategy and how these are affected by the changing landscape of technologies. He is also interested in the public policy and regulatory implications of these changes.

TECHNOLOGY, BUSINESS, AND ENVIRONMENT PROGRAM

The Technology, Business, and Environment Program (TBE) studies the effectiveness of the environmental tools and practices available to management. These include conceptual frameworks like industrial ecology as well as design for environment approaches that incorporate environmental concerns into design decisions. TBE's research identifies the learning and the change firms experience when they embrace environmental policies and adopt voluntary codes of conduct. The program also analyzes how public policy can facilitate business efforts to adopt environmental practices.

Highlights of the year are as follows:

- Analysis of the variance in the environmental management practices of firms adopting Responsible Care and ISO 14001, two environmental management standards
- Evaluation of StarTrack, a pilot program of the U.S. Environmental Protection Agency that is testing the use of third-party verification of environmental performance of firms as a substitute for direct agency inspections
- Initiation of a study to explore the potential of trade association codes of conduct for improving environmental performance in developing countries

Next year's goals are to continue these research areas, focusing on the role of a firm's culture, business strategy, and technology competence in shaping how it interprets and manages its environmental responsibilities. A new goal is to launch a study of the implications of e-commerce, and the growing use of environmental management standards in supply chain management, on environmental performance.

John Ehrenfeld, Director of the Technology, Business, and Environment Program since its inception in 1989, retired in April 2000. Jennifer Nash, Associate Director since 1997, is Acting Director.

For more information, visit the web site at http://tbe.mit.edu/.

TECHNOLOGY AND LAW PROGRAM

The Technology and Law (T&L) Program offers research opportunities and graduate-level courses focusing on the interface of law and technology. Research activities include the design and evaluation of policies that encourage technological change for preventing chemical pollution through regulation, liability, and economic incentives, promote environmental justice by involving communities in governmental decisions that affect their health, safety, and environment; and address the effects of globalization on sustainability.

T&L offers a two-semester sequence in environmental law and policy: Law: Technology, and Public Policy, a core subject in the Technology and Policy Program; and Sustainability, Trade, and Environment, listed jointly with Engineering and Sloan.

Recent Publications From The Program

"An Innovation-Based Strategy for a Sustainable Environment," N. A. Ashford, in *Innovation-Oriented Environmental Regulation: Theoretical Approach and Empirical Analysis*, J. Hemmelskamp, K. Rennings, F. Leone (Eds.) Springer Verlag, Heidelberg, New York 2000.

"Encouraging Inherently Safer Production in European Firms: A Report from the Field" N.A. Ashford and G. Zwetsloot, *Journal of Hazardous Materials*, Special Issue on Risk Assessment and Environmental Decision Making, A. Amendola and D. Wilkinson (eds), 1999.

"Negotiation as a Means of Developing and Implementing Environmental and Occupational Health and Safety Policy," Charles C. Caldart and Nicholas A. Ashford, *Harvard Environmental Law Review*, 23(1):141-202, 1999.

Future planned activities include completion of textbooks on environmental law and policy; and globalization, technology, and sustainability.

T&L program is directed by Professor Nicholas A. Ashford and involves Charles C. Caldart, Research Associate, CTPID, and Lecturer in Civil Engineering. For more information, visit the web site at http://web.mit.edu/ctpid/www/tl/.

Fred Moavenzadeh

CENTER FOR TRANSPORTATION STUDIES

The Center for Transportation Studies was established in 1973 to develop and coordinate the wide range of transportation-related activity at MIT. It provides a focal point for transportation education, facilitates transportation research, conducts an outreach program to the transportation industry, and encourages a sense of common purpose among the many departments, centers and laboratories involved in transportation and logistics at MIT.

The center's web address is http://web.mit.edu/cts/. In addition to a wealth of information about the center and its programs, the site includes descriptions of current research projects in transportation, and a listing of MIT theses in transportation since 1980. Transportation faculty and research staff are also listed with their areas of interest, along with connections to other interesting resources on the Web.

Eighteen new students arrived on campus this fall to enter the center's new Master of Engineering in Logistics program, an intensive nine-month degree track preparing graduates for logistics management careers in manufacturing, distribution, retail, transportation and logistics organizations.

Again this year, because of the high quality of applications, qualifying for graduate admission for transportation studies was increasingly difficult. This year, 185 applications were received for graduate studies in transportation—including the MST, the MLOG and the PhD programs—and 54 students were enrolled in 1999–2000. Funding was found for 65% of the students.

During the past academic year, over 200 projects were posted on the center's Current Research listing, organized in eleven categories and representing the work of more than 50 researchers in more than a dozen departments and research centers. Many of those entries were research programs which included within them still more individual projects. An important addition to that listing this year was a major new study of the global airline industry funded by the Alfred P. Sloan Foundation. The study is being performed by a multidisciplinary team from the schools of engineering, management and humanities & social sciences. The goal of the work, which began in September, is to develop a body of knowledge for understanding the development, growth and competitive characteristics of the industry as a whole. The program is addressing the management, economics and operations of international, domestic, regional and local carriers, and the scope includes interactions with aircraft and engine manufacturers, with airports, with air traffic control and with agencies such as the FAA and the International Civil Aviation Organization.

MAJOR NEW PROJECTS

MIT's New Agelab Researching Technology For Healthy Aging

A new research lab is in the process of being established at MIT to promote healthy independent living throughout the human lifespan. Based in the School of Engineering, the AgeLab is a partnership between MIT, industry and the aging community to pioneer new technologies which respond to the needs and preferences of older adults, their families and their care providers. Drawing on a number of disciplines—including engineering, computer science, planning and management, as well as the health and social sciences—the Lab aims to create a world class center of excellence at MIT in aging research.

One of the most important areas of the Lab's research will focus on lifelong transportation—the use of technology to provide a continuum of attractive transportation alternatives as we age. Research will seek to define a global standard for smart design and intelligent vehicle applications for the 50+ driver; to explore the potential of continuous personal skill-assessment technologies; to invent new special vehicle platforms to facilitate mobility; and to create a community transportation vehicle for non-drivers in the suburban market.

Supply Chain Visualization Project

In a unique multi-center research initiative, the Supply Chain Visualization project received first-year funding ($715K) from founding sponsor Intel. The project intends to develop a proof-of-concept demonstration of a system that will integrate three kinds of capabilities—a process knowledge repository for structuring, storing, and sharing knowledge about supply chain processes; graphical and tangible user interfaces for interacting with this knowledge; and simulation tools for simulating the performance of existing or potential supply chain configurations.

These capabilities are being combined in order to create a tool to visualize supply chain processes as three-dimensional assemblies of interchangeable parts that can be connected to other activities in various ways to create rapidly reconfigurable supply chains. With this approach, each supply chain activity is visualized as a kind of "Lego block" that can be connected to other activities in various ways to create rapidly reconfigurable supply chains. Users will be able to represent their existing supply chains and easily experiment with many new possibilities by "plugging" these different components together in different ways. In many cases, users will build these models by

manipulating actual physical objects (such as blocks and cords) that are connected to computers that sense the arrangements of the physical objects. These "tangible interfaces" will be supplemented, as needed, by graphical user interfaces using conventional computer screens.

Using a system dynamics model, it will be possible for users to construct, for example, a supply chain model. This could be accomplished by plugging blocks together, setting parameters (such as demand and delay), manipulating physical knobs or levers, and then observing the simulated performance of the system they have created by looking at physical outputs such as lights or dials. The main purpose of this tool would be as a learning rather than an optimization tool.

MAJOR MEETINGS

Managing Change In The Supply Chain

About 120 people convened at the MIT Faculty Club in January for a two-day meeting on managing change in the supply chain. The group included twenty students from MIT's new Master of Engineering in Logistics program, all of whom were enlisted in Logistics and Change Management, a seminar being held during Independent Activities Period and designed to dovetail with this meeting, offering the conference speakers as guest lecturers. The speakers were Michael Scott Morton of the Sloan School; Cynthia Stoddard, Senior Vice President & Chief Information Officer at Circle International; Patrick Canavan, Senior Vice President & Director of Global Leadership & Organizational Development at Motorola; Rob Iverson, Senior Vice President, Distribution & Transportation, Nestlé Logistics Services Division; Jack Blaisdell, Program Manager for Hub 2000, United Parcel Service; Jeff Fatica, President, and Natalie Ranus, Director of Human Resources, both from Pentacon.

Logistics On The Internet: Auctions And Fulfillment

Over 90 people convened at the MIT Faculty Club in March for a two-day seminar about logistics on the Internet, focusing in on two specific aspects of the topic: auctions and fulfillment. Industry speakers at the meeting were Jim Miller, Vice President Supply Chain, for Amazon.com; Mohsen Moazami, Managing Director of Cisco Systems; Massimo Russo, e-strategy leader for General Electric Aircraft Engines; and Lee Wilwerding, Director of Internet Operations for Wal-Mart Stores. MIT participants were Sloan School Professors Sandy Jap and Larry Wein, with PhD candidate Jeremy Gallien, and Center Director Yossi Sheffi, CEO of Logistics.com.

Frontiers Of Global Supply Chain Management

Over 100 people traveled to Paris in November for a two-day conference on the frontiers of global supply chain management. Jointly sponsored by the center and MIT's Industrial Liaison Program, the meeting was held in part to expand both programs' memberships in Europe, and at that it was highly successful. At the start of the meeting, the center's Affiliates Program in Logistics boasted a roster of six European members, but by the end of the conference two more European firms had joined on the spot—Schenker BTL, a third-party logistics firm, and the Lego Group, makers of playthings for children from 0-16 years. Within a few weeks after that, a third European firm joined, as well—international retailer Marks and Spencer—bringing the European membership to fully a quarter of the program's total. The meeting featured presentations from five affiliates: Intel, Staples, The Sema Group, Procter & Gamble and Volkswagen focused on an essential issue facing international business today: how to manage a global enterprise and its global supply chain in an integrated way. (It also featured a presentation by MIT Professor Charlie Fine, author of *Clock Speed: Winning Industry Control in the Age of Temporary Advantage* (1999, Perseus Books), a copy of which was sent to every member of the Affiliates Program.

SMALLER FUNCTIONS

The center's Distinguished Speakers Series this year included Don Schmickrath, General Manager of Hewlett-Packard's Product Processes Organization; Raymond Greer, President of Ryder Integrated Logistics; Gary Girotti, VP of Logistics Planning Applications at i2 Technologies; Jane Garvey, Administrator of the FAA; Frank Kruse, head of the Chicago Transit Authority; Jose Crespo de Carvalho, ISCTE; Jaime Lerner, Governor of the State of Parana, Brazil; Alan Altshuler, Director of the Taubman Center for State and Local Government at Harvard's Kennedy School of Government; Matt Edelman, Executive Director of TRANSCOM; Kenneth Wykle, head of the US Federal Highway Administration; and John Bermudez, Group VP, Research, and Bob Kraus, Service Director, Quantitative Research, AMR Research.

The center again held an open house in the spring for applicants who had been accepted to the Master of Science in Transportation, the PhD in Transportation and the Master of Engineering in Logistics programs for the fall, giving them a chance to meet with current students and faculty and to see the more human side of the MIT experience.

AFFILIATES PROGRAM IN LOGISTICS

Every year, as part of the center's Affiliates Program in Logistics, one of the members hosts the rest of the group at a two-day meeting and tour of one of its facilities. This year, in September, about sixty program members convened

at the offices of Yellow Freight in Overland Park, Kansas. The meeting the theme of which was 'Creating a Customer-Centric Culture'—included a demonstration of the technology Yellow is now using at their customer service centers. The demonstration involved a real-time eavesdrop on a service representative handling several customer calls; looking at a projection on a big screen in the meeting room, attendees were able to see exactly what the service rep was seeing on his computer screen, while listening live to both sides of his telephone conversation. It was a daring presentation, going live as it did, and it turned out to be a revealing demonstration not only of the technology, but also of the training Yellow has put into their customer service reps. At the end of the two-day meeting, the assembly heard from two of Yellow's customers - Ryder Integrated Logistics and Wal-Mart - on the results of Yellow's efforts to transform itself from a transportation commodity services provider to a transportation-based tailored services provider. An interesting aspect of those presentations was that Wal-Mart, Ryder and Yellow all are members of the Affiliates Program.

The center welcomed ten new members to the Corporate Affiliates Program this year, representing a range of industries and logistics/supply chain concerns. The new members were 3Com Corporation; Atraxis; Electrocomponents; Ford Motor Company; Lucent Technologies; Owens Corning: ShippersNetwork; Staples; Wal-Mart Stores; and Sema Group. Continuing members are APL; Canadian Pacific Railway; Caterpillar; CSX Transportation; Emery Worldwide; Federal Express; General Electric; Gillette; Lego System; M&M Mars; Michelin; Nestle; NYK; Osram Sylvania; Polaroid; Ryder System; Schenker-BTL; Sony; Unilever; Transcentric (previously known as Union Pacific); United Parcel Service; Volkswagen; Wisconsin Central; and Yellow. The program also welcomed a new director this summer (see below).

INTEGRATED SUPPLY CHAIN MANAGEMENT PROGRAM

Since its inception in FY95, the Integrated Supply Chain Management Program has grown to eleven members—Cummins Engine, Helix Technology, Intel Corporation, Lucent Technologies, Monsanto, Pentacon, Procter & Gamble, Siemens, Texas Instruments, Transcentric (previously Union Pacific Technologies) and Volkswagen AG. In addition to the 15+ research projects that had been initiated in the first five years of the program, the 2000 Program includes collaborative work with the Leaders for Manufacturing Program and continued collaboration with the Center for Coordination Science. There were also twenty-one collaborative exchange and senior executive events held at sponsor sites and the MIT campus.

PROFESSIONAL EDUCATION

Logistics and Supply Chain Management: E-Commerce Meets E-Logistics

Every summer for the past eighteen years, the center has offered an intensive weeklong seminar on logistics. Attended by representatives of carriers, shippers and third-party logistics providers, the course is structured around a series of lectures and case studies, and involves intensive interaction among the participants. This year 56 participants attended the course.

PERSONNEL CHANGES

While the center's Director was on partial leave this year, day-to-day business was supervised by Acting Director Joseph Coughlin, who continued to serve as Director of the New England University Transportation Center and of MIT's new AgeLab.

David Simchi-Levi, a major player in the field of transportation and logistics, accepted a dual appointment in MIT's Engineering Systems Division and in the Department of Civil and Environmental Engineering. Previously a professor of industrial engineering and management sciences at Northwestern, Simchi-Levi has served as principal investigator for over $1.5 million in funded academic research, making significant contributions to knowledge in vehicle routing and scheduling, distribution systems, bin-packing problems and location problems. His research interests also include integration inventory control and transportation costs; inventory theory; location theory; production system design and control; scheduling and sequencing; supply chain management; and telecommunications networks design and control.

This spring, after seven years at the Center for Transportation Studies, Peter Metz, Director of the center's Affiliates Program in Logistics, moved across campus to start a new life as Executive Director of MIT's new Center for eBusiness. Metz' seven years as Deputy Director of the center was a period of significant growth here—in academic, research and outreach activities, all three. The flagship Master of Science in Transportation program was strengthened, the new Master of Engineering in Logistics program was begun, and the research scope was expanded to logistics and supply chain management. Part of that shift in research focus was brought about by the establishment of the Integrated Supply Chain Management Program, an effort which Metz undertook shortly after joining the center and which eventually grew to the point that a full-time Director was hired to develop it to its current form. (The director of that program now is Jim Rice, who was also Acting Director of the Affiliates Program in Logistics until the new director was hired).

This coming summer, Ed Schuster will join the center as the new Director of the Affiliates Program in Logistics. A logistics and operations specialist with over fifteen years experience in consumer packaged goods, he holds a master of public administration from Gannon University in Erie PA and a bachelor of science in food technology from Ohio State. He began his career as a Sanitation and Cook Room Supervisor for Oscar Mayer in Sandusky, Ohio, then in 1982 joined Welch's in Concord, Massachusetts—makers of Welch's Grape Juice and a number of other grape products -as an industry analyst. In 1999, after five years in charge of logistics planning in their logistics department, he was promoted to corporate manager of operations planning in the supply chain department.

During his time at Welch's, Schuster led a team that contributed $8 million to the bottom line by reducing inventory; helped save another $2 million through streamlining the supply chain; worked with researchers at Penn State to develop the Juice Logistics Model and the Harvest Planning Model; and established the continuous replenishment planning program with Wal-Mart. In addition to any number of other achievements at Welch's, he also established the kosher program for all Welch's products. A member of half a dozen professional societies—including the Council of Logistics Management and the Institute for Operations Research and Management Science - Schuster has an extensive publishing history and has served in editorial functions for the Production and Inventory Management Journal and the Journal of Operations Management, among others. He also has extensive experience in public speaking and teaching.

NEWLY PUBLISHED BOOKS

JR East Professor Joseph Sussman, previously Director of the Center for Transportation Studies and one of the early architects of the US program in intelligent transportation systems, published a new book in May with Artech House Publishers. *Introduction to Transportation Systems* provides the 30-point framework underlying most major transport systems and examines efforts to improve them in both the freight and passenger sectors.

Jim Rice, Director of MIT's Integrated Supply Chain Management Program, was one of the authors of a new book released by the National Academy of Sciences. *Surviving Supply Chain Integration*, a guide to supply chain strategies for small manufacturers, identifies action steps for small and medium-sized manufacturers to improve their supply chain management.

RECOGNITION

Rafaela Arriaga Oliveira (MLOG '00) was presented the 'Premio Escolar' award as best student in her graduating class at the New University of Lisbon School of Sciences and Technology. Her degree was in industrial production engineering.

Joan Walker, doctoral candidate in transportation, was chosen by the New England University Transportation Center as Outstanding Student of the Year 2000. Her selection was based on a regional competition that included graduate students from MIT and Harvard University plus the six New England state universities.

More information about the center can be found on the World Wide Web at http://web.mit.edu/cts/.

Yossi Sheffi

CONCOURSE

Concourse is a highly structured and integrated program for freshmen covering the standard core curriculum in mathematics, physics, chemistry, and humanities. The structure of Concourse follows that of the standard curriculum with scheduled lectures, recitations, problem sets and quizzes. Small class size (limited to 60 students) and extensive personal interaction with senior faculty and tutors provide students with the intimate atmosphere of a small school while retaining all of the excitement and resources of a large institution like MIT.

For the fall 1999 term, 53 freshmen enrolled in Concourse. For the spring 2000 term, enrollment was 15, a 50% decrease from the spring of 1999. For the Independent Activities Period, four students participated in Concourse's SP.345, a twelve-unit course on problem solving. From the Concourse Program, 59% of the students went on to major in the School of Engineering; 28% to majors in the School of Science; 3% to Architecture and Planning; 3% to Humanities and Social Science; and 3% remained undesignated.

SP.344, "Problems in Electricity and Magnetism" was again offered in the spring term. The joint staff meetings of Concourse and the Experimental Studies Group resulted in a series of proposals for the teaching of freshman calculus in modular form.

Members of the Concourse faculty for 1999–2000 were Philip Bradley, Department of Mathematics; Roberta Brawer, Lecturer, Anthropology; Dr. Yuri Chernyak, Harvard-MIT Division of Health Sciences and Technology; Francis Poulin, Department of Mathematics; Dr. Kevin Rhoads, Lecturer, School of Engineering; Professor Robert M. Rose, Department of Materials Science and Engineering; Professor Judah L. Schwartz, Professor Emeritus, School of Engineering; Christopher Sawyer-Laucanno, Writer-in-Residence, Program in Writing and Humanistic Studies; and Dr. Jeremy Wolfe, Visiting Associate Professor, Department of Brain and Cognitive Sciences. Sixteen MIT undergraduates in the fall and ten undergraduates in the spring were employed as teaching assistants for recitations, grading, and running evening tutorials in chemistry, calculus, physics and differential equations.

The Concourse Program was overseen by Robert M. Rose as Director and Ms. Cheryl Butters of the School of Engineering as Program Coordinator.

More information about Concourse can be found on the World Wide Web at http://web.mit.edu/concourse/.

Robert M. Rose

INDUSTRIAL PERFORMANCE CENTER

The MIT Industrial Performance Center (IPC) is dedicated to the study of industries in the United States and in other advanced economies. The center brings together the intellectual resources of MIT in a search for fresh insights into the nature and origins of successful industrial performance. Through our research we seek to help leaders in business, labor, government, and the universities better understand global industrial development and to work with them to develop practical new approaches for strengthening public policies, business strategies, technical practices, and educational programs. With the participation of about 30 faculty members and more than 50 students from the Schools of Engineering, Management, Humanities and Social Sciences, and Architecture and Planning, the center today serves as a listening post on industry, monitoring and interpreting industrial trends, techniques, and patterns of organization.

EDUCATIONAL PROGRAM HIGHLIGHTS

The center works to involve MIT faculty and students in activities that bring the real-world performance problems of industry into our classrooms and laboratories. It creates opportunities for researchers to move beyond the boundaries of the Institute into systematic observation and learning about industrial practice in real-world settings. Many of the most important problems in the management of technological enterprise are occurring at the interface of engineering and the social and behavioral sciences. The center is committed to a research enterprise that promotes cross-fertilization and mutual enrichment of these disciplines.

For Academic Year 1999–2000, the IPC awarded three new doctoral fellowships. Pierre Azoulay received a Fellowship for his research using the setting of drug development in the pharmaceutical industry to explore more general issues of incentive design in data producing industries. Jeffrey Furman was awarded a Fellowship to pursue a study of the impact of the magnitude and quality of a region's public and private scientific base on the organization and productivity of industrial research facilities. Apichai W. Shipper was awarded a Fellowship for his research on innovative social institutions for foreign workers under globalization.

During this past academic year the center launched a new Faculty Seminar entitled *The Entrepreneurial, Global University.* The seminar examines the social, economic, and technological trends that are reshaping the higher education industry and that may ultimately redefine its role in society. It is designed to serve as a forum in which leading members of the MIT community and the Boston-area academic community more broadly can consider the full range of these developments and reflect on their implications for strategy and practice.

RESEARCH HIGHLIGHTS

The center's research is organized around four major themes: Technology and the Changing American Workplace; Organizing Innovation; Globalization and its Implications for Industrialized Societies; and Local Innovation Systems.

The center continues its major research program on globalization. The term 'globalization' refers to the set of changes in the international economy that are tending towards the creation of a single world market for capital, goods, and services. In each of these dimensions, globalization raises new challenges for sustaining innovation, growth, societal well being, and broad political legitimacy in the nations it encompasses. The IPC Globalization Study focuses on one aspect of these developments: the fragmentation of the production systems of firms in the advanced economies, and the relocation of parts of these enterprises to other societies. Research on this topic is currently underway in the United States, Europe, Japan, Mexico, China, and Latin America. Under the auspices of the Globalization Study a 20-person team of MIT faculty and student researchers completed the first year of the three-year Taiwan Project, an investigation of Taiwan's experiences and prospects in globalizing production, innovation, and employment. The IPC Globalization Study team is led by Professor Suzanne Berger (Political Science), and also includes Professors Taiyo Akiwande (EECS), Don Lessard (Sloan), Richard Lester (Nuclear Engineering), Richard Locke (Sloan), Michael Piore (Economics), Charles Sodini (EECS), Sonny Siu (Mechanical Engineering), and Edward Steinfeld (Sloan), and also includes research affiliates from Germany, Japan, and Taiwan. In July the IPC held its first annual Globalization Conference in Taipei, Taiwan. The center also co-sponsored, with Academic Sinica, a Workshop on Networked Production and Globalization which brought the IPC research team together with leading social scientists and technologists from Taiwan.

Professors Lester and Piore and their students continued their research on design and product development. Their main focus is on the development of a new theory of interpretive management applicable to product development and more generally to the management of modern business enterprise. Their research is built on an empirical

foundation of research on new product development in the cellular telephone, apparel, medical device, automobile, and systems integration sectors.

This year the IPC launched a new program of research on local innovation systems. The research centers on a comparative study of the conditions of innovation in several local and regional agglomerations of technology-based enterprise, including the Boston area in the United States, the Cambridgeshire cluster in the U.K., the Hsinchu-Taipei corridor in Taiwan, the Helsinki region of Finland, and technology clusters in Israel and Ireland. The research will explore the relative importance of national and local influences on innovation performance. It will focus on the role of research universities as contributors to innovation and economic growth in these regions, and also on the relationships between large and small firms.

In December the IPC organized a conference at MIT to present the results of its research on "International Changes in Industrial Innovation: Consequences for the Research System." Approximately 250 CEOs and chief technology officers from North America, Europe and Japan attended. This was a collaborative research project with the Fraunhofer Institute for Innovation and Systems Research of Karlsruhe, Germany and the National Institute for Science, Technology and Economic Policy in Japan. The project included a major global benchmarking survey of the technology management practices of 200 of the world's largest technology-intensive corporations, based in North America, Europe, and Japan. The IPC team was led by Professors Richard Lester and Ed Roberts.

More information on the Industrial Performance Center can be found on the World Wide Web at http://web.mit.edu/ipc/www/.

Richard K. Lester

INTEGRATED STUDIES PROGRAM

The Integrated Studies Program (ISP) offers a curriculum for first-year students built around the study of technologies as they are practiced in different cultures and historical periods. ISP promotes a form of education that seeks to show students the connections among ideas and processes in the sciences, humanities, and social sciences. Hands-on learning complements the theoretical work that is a typical component of most first-year coursework. ISP strives to provide students the academic and social foundation for success at MIT and beyond by creating a community devoted to team approaches to design and problem solving, inquiry, enhanced communication skills, and life-long learning.

CURRICULUM

The centerpiece of the year's curriculum were two HASS-D subjects focused on technologies in their cultural and historical contexts. In fall, students studied technologies ranging from food production and preparation in China to metalsmithing in the context of traditional Japanese samurai culture. Professor Arthur Steinberg and Dr. Peter Dourmashkin held primary responsibility for the subject, with Ms. Frederica Steinberg coordinating the integrated writing component. Professor Steinberg and Dr. Dourmashkin visited Greenwich Observatory to collect materials on John Harrison's search for a way to keep longitude. Their research formed the basis for an enhanced unit on timekeeping. In spring, technologies studied ranged from Andean weaving and the role of textiles as a communication medium to the social impact of the invention of the internal combustion engine. A highlight of the semester was a project that asked students to design a textile mill to be set in Lawrence, Massachusetts, in 1840. Working in small teams, they researched mill machinery, building design, land costs, labor needs, and other issues. Students presented business plans to build a mill before a panel of potential "investors." Dr. Jonathan Wylie joined Dr. Dourmashkin and Ms. Steinberg in teaching the subject while Professor Steinberg was on sabbatical leave. ISP continued to modify approaches within existing modules to improve students' competencies in all modes of communication, and in working as part of a team to develop and promote an idea.

Workshops connected to the humanities subjects allowed students to practice all the technologies studied. Guest presenters included Mr. Toby Bashaw, blacksmith; Ms. Debbie Watson, weaver and dyer; and Dr. Ed Franquemont, anthropologist and Incan weaving specialist.

ISP continues to focus attention on developing a strong writing curriculum under the leadership of Ms. Steinberg, with assistance from Ms. Debra Aczel. Students in the fall and spring HASS-D subjects, write several papers that increase in length and sophistication; produce outlines, rough drafts, and abstracts; spend considerable time working with writing graders/tutors to revise papers.

ISP hosted a weekly luncheon for freshmen with speakers from MIT and the greater community to lecture about their work.

Students attended lectures in math and science subjects with the rest of the freshmen class, but were able to choose ISP-sponsored recitations in some subjects. Most students enrolled in 8.01x and 8.02x, experiential physics courses.

STAFF AND ENROLLMENT

Professor Steinberg was on sabbatical leave spring semester. Program administrator was Ms. Debra Aczel and Ms. Rachel Jacobs was administrative assistant.

41 students (25 male, 16 female) enrolled in fall. 35 students (28 male, 7 female) enrolled in spring.

More information about this department can be found on the World Wide Web at http://web.mit.edu/isp/www/.

Arthur Steinberg

LABORATORY FOR COMPUTER SCIENCE

The MIT Laboratory for Computer Science (LCS) is an interdepartmental laboratory whose principal goal is to create computer-communications technologies of high social utility with equal attention to forefront technological underpinnings and human utility.

Founded as Project MAC in 1963, the laboratory developed one of the world's earliest time-shared computer systems: the Compatible Time Sharing System (CTSS) and its successor, Multics, which laid the foundation for many of today's systems and approaches, such as virtual memory, tree directories, on-line scheduling algorithms, line and page editors, secure operating systems, access control techniques, computer-aided design, and two of the earliest computer games, space wars and computer chess. Our partner in the Multics effort, AT&T, used many of the early ideas in their design of Unix.

These early developments laid the foundation for the laboratory's work on knowledge based systems—the Macsyma program for symbolic mathematics—natural language understanding, and (with BBN) the development and use of packet networks in the Arpanet. In the late 1970s, Project MAC, renamed as the MIT Laboratory for Computer Science, embarked on research in clinical decision making, public cryptography, distributed systems and languages and parallel systems. These led to the RSA encryption algorithm, data abstractions which served as foundations of object oriented programming, the Clu and Argus distributed systems, the dataflow principle and associated languages and architectures of parallel systems (Monsoon, Id and StarT), local area networks, program specification and workstation development, where the laboratory contributed the earliest UNIX ports and compilers and the Nubus architecture. This research also led to the X Window System, a computer intercommunication and user interface system which was further developed by the laboratory's X-Consortium and was widely used in over one thousand different software products. Since 1994, LCS has been the principal host of the World Wide Web Consortium of some 450 organizations that helps set the standard of a continuously evolving world wide web.

The laboratory's current research falls into four principal categories: Information Infrastructure and Distributed Systems; Human-machine interaction; Science and Computer Science research; and Theory. The principal goals of these four categories are as follows:

In the areas of *Information Infrastructure and Distributed Systems*, we wish to understand principles and develop technologies for the architecture and use of highly scaleable information infrastructures that interconnect human-operated and autonomous computers. Transactions among such distributed systems involve the purchase, sale and free exchange of information and information work toward electronic commerce and shopping, health care, education, business, government and many other uses as well as increased automation of human work. We wish to explore new emerging forces such as collaboration across space and time and automation of computer-to-computer actions. We also expect this overall research to have a broad impact on future systems because virtually every machine will be connected to some information infrastructure and such infrastructures are expected to last for a very long time. The laboratory's World Wide Web Consortium is a significant and major focus of our work in this area.

In the *Human-Machine Interaction* area, our technical goals are to understand and construct programs and machines that have greater and more useful sensory and cognitive capabilities so that they may communicate with one another and with people toward useful ends. The two principal areas of our focus are conversational spoken dialogue systems between people and machines and graphics systems used predominantly for output. In this area, we also strive to construct tomorrow's servers by harnessing the power and economy of numerous processors working on the same task; relevant research spans parallel hardware and software architectures, that yield cost-performance improvements of several orders of magnitude relative to single processors.

In the *Science and Computer-Science* area, we are interested in exploring opportunities at the boundary of traditional science and information technology. Our research includes an extensive program of clinical decision systems research between medicine and computer science, and several research activities in biology and computer science.

Taken together, these three thrusts define the laboratory's overarching goal: development, understanding and better human communication with tomorrow's information systems. In the laboratory's fourth category of research, *Theory*, we strive to discover and understand the fundamental forces, rules, and limits of Information Science and Technology. As a result, theoretical work permeates our research efforts in the other three areas; for example, in the

pursuit of parallel algorithms, fault tolerant computer networks, and privacy and authentication of communications. Theory also touches on the logic of programs, the inherent complexity of computations, and the use of cryptography and randomness in the formal characterization of knowledge. The laboratory expends a great deal of effort in theoretical computer science because its impact upon our world is expected to continue its past record of improving our understanding and helping us pursue new frontiers with new models, concepts, methods, and algorithms.

HIGHLIGHTS

Oxygen Launch

Oxygen is a new computer based on pervasive human-centered computing. It pulls together an abundance of technological resources toward creating a new breed of systems that cater to human–level needs, rather than machine-level details. This major research project was launched in September 1999, following funding by DARPA of a proposal for research to that end. Led by LCS, Oxygen is a collaborative effort with the Artificial Intelligence Laboratory and involves some 20 faculty and 150 researchers. Oxygen consists of eight new technologies: handheld units (Handy 21's); stationary computers (Enviro 21's), which are also connected to physical devices; a new network approach (Net21) that meets the needs of wireless mobility; (4) built-in speech understanding; individualized knowledge access; automation; collaboration; and customization. The first prototype of Oxygen should be ready two years hence. The project's duration is five years. Oxygen is a broad project, an integrative effort that cuts across the Lab's four principal categories of research. When it reaches full size, it is expected to occupy about one-third of LCS and AI Lab researchers. In May 2000, six companies (Acer, Delta, Hewlett Packard, Nokia, NTT and Philips) became partners to MIT in this effort, forming the Oxygen Alliance.

Network And Mobile Systems

Networks of the future will include a wide variety of mobile and wireless appliances and devices, in addition to general-purpose computers. The newly formed Networks and Mobile Systems group at LCS (http://nms.lcs.mit.edu/) co-led by Professors Hari Balakrishnan and John Guttag, is developing systems to enable a large class of pervasive computing applications for a world in which communication is ubiquitous and computation extends to network-enabled specialized devices (e.g., cameras, coffee machines, sensors, actuators, etc.). Realizing this vision is not easy because these environments are dynamic, network nodes are mobile, network performance fluctuates, and there is little known today about how to discover resources and services in this world.

The group's approach to solving the problem of mobile resource discovery is a new naming system, called the Intentional Naming System (INS). In INS, names are "intentional," describing a sought resource by its properties (e.g., "find me the nearest, least-loaded color printer that can handle transparencies") rather than by its network location (as in "printer643.lcs.mit.edu" or "18.31.0.99"). Intentional naming provides flexibility and decentralized management, that allows applications to describe "what" they are looking for. Name resolvers in the network route requests to the appropriate locations by maintaining a dynamic mapping between service descriptions and network locations. This allows applications to self-organize because any data they need is obtained for them by INS based only on their descriptions, freeing them of the need to implement this machinery. A particularly interesting class of applications enabled by INS are "location-aware," meaning that they can change their behavior depending on the location of the user. To enable this, the group has designed an accurate location-support system called "Cricket," which uses a combination of radio-frequency and ultrasonic transmissions to allow mobile applications to discover and adapt to the location of resources, without compromising the privacy of mobile users.

Spoken Language Systems

This group has recently decided to offer open source license for their Galaxy Communicator architecture for conversational systems, so that institutions worldwide can adopt this standard without encumbrance. While the Group continues to conduct dialogue modeling research in order to support increasingly complex applications such as air travel planning, they also are starting to develop a set of tools that will enable developers and users to implement their own, simpler applications. These light systems, as they are called, will be particularly useful in the development of the Oxygen system.

World Wide Web Consortium

As of this report, 450 organizations have joined the consortium in order to participate in and contribute to the orderly evolution of the World Wide Web (W3). With three hosts and seven offices worldwide, the W3C is growing in influence, as offices succeed in promoting W3C work in specific regions. Key W3C technical developments include the growth of Extensible Markup Language (XML) and metadata efforts resulting in the

W3C recommendation for Resource Description Framework (RDF). During this reporting period, Mr. Tim Berners Lee, director of the W3C, was named by Time Magazine as one of the twenty leading Scientists and Thinkers of the 20th Century. He was also awarded the 3Com Founders Chair, a newly established chair for LCS senior researchers. As the consortium size increases, it is facing, increasingly, the challenge of balancing a broad-based consensus for standards versus "driving" the Web forward based on technological capabilities and opportunities.

DISTINGUISHED LECTURE SERIES

The laboratory's Distinguished Lecturer Series included presentations by Ruzena Bajcsy, Assistant Director, Directorate for CISE, NSF; Mahadev Stayanarayanan, Professor, Carnegie Mellon University; Vinton Cerf, Senior Vice President, MCI Telecommunications Corporation; and Ross Anderson, Professor, Cambridge University Computer Laboratory.

The laboratory is organized into 19 research groups, an administrative unit, and a computer service support unit. The laboratory's membership comprises a total of 414 people, including 93 faculty and research staff, 190 graduate students, 46 undergraduate students, 52 visitors, affiliates, and postdoctoral associates and fellows, and 33 support staff. The academic affiliation of most of the laboratory's faculty and students is with the Department of Electrical Engineering and Computer Science (EECS). About 38% of the laboratory's funding comes from the US Government's Defense Advanced Research Projects Agency. The laboratory is also funded by and has extensive links with industrial organizations. These include partnerships for the construction of major systems such as the Oxygen Alliance, and consortia for the development of standards, such as the World Wide Web and the Oxygen Alliance.

More information about the laboratory can be found on the World Wide Web at http://www.lcs.mit.edu/.

Michael L. Dertouzos

LABORATORY FOR ELECTROMAGNETIC AND ELECTRONIC SYSTEMS

The mission of the Laboratory for Electromagnetic and Electronic Systems (LEES) is to be the focus for research and teaching in electric energy from its production through its processing to its utilization, and in electromechanics from the macroscopic through the microscopic levels. Electric energy and electromechanics are defined broadly to include power systems monitoring and operation; automatic control; power electronics; high voltage engineering; and conventional, continuum and biological electromechanics. Much of the work of the laboratory is experimental, and industrial sponsorship represents a large fraction of the laboratory's support. The laboratory's professional staff consists of 7 faculty from EECS, 1 Principal Research Engineer, 1 Principal Research Scientist, 2 Research Scientists, and approximately 50 graduate students. The laboratory faculty and most of the staff are heavily involved in both undergraduate and graduate teaching. Faculty from the departments of ME, CE, MS&E and NE are collaborators in many of the laboratory's programs, and there are extensive joint activities with the Microsystems Technology Laboratory (MTL) and the Laboratory for Information and Decision Systems (LIDS).

During the past year the laboratory has experienced a 35% increase, to 46 companies, in its Consortium on Advanced Automotive Electrical/Electronic Components and Systems (the "Automotive Consortium") membership, demonstrated a radical innovation in automotive alternator design, developed a new magnetic field based concept for nanoactuators, shown that magnetically triggered gels can function as active vibration dampers, and developed a new model for exploring cascading failures in complex interacting electric power networks.

AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS

Professor John G. Kassakian, Principal Research Scientist Dr. Thomas A. Keim and Research Scientist Dr. David Perreault lead the laboratory's work in automotive electrical and electronic systems. This work is sponsored primarily through the laboratory's Consortium on Advanced Automotive Electrical and Electronic Components and Systems. The consortium membership now numbers 46, an increase of 12 from one year ago, and represents almost all of the world's major automobile manufacturers and component suppliers.

Dr. Perreault and graduate student Vahe Caliskan have developed a new design for automotive alternators that enables dramatic increases in alternator output power and substantial improvements in efficiency. The new design, which uses a switched-mode rectifier, preserves the simplicity and low cost of conventional alternator designs and can be manufactured within the existing manufacturing infrastructure. Improvements of a factor of two in output power and 20 percentage points in efficiency have been experimentally demonstrated. Higher power capability is a critical issue for future vehicles, while the improved efficiency is projected to reduce the consumption of gasoline in the United States alone by more than 2 billion gallons/year. The new technology also provides other improvements of central importance to future 42 V electrical systems, such as greatly improved transient control and the ability to use the alternator to jump charge the high-voltage battery from a low-voltage source. These developments have resulted in three patent filings, and are expected to greatly facilitate the rapid introduction of high-power and high-voltage electrical systems in automobiles.

Research Assistant Edward Lovelace completed a doctoral thesis on the design of interior permanent magnet crankshaft starter alternators. Ford Motor Company is building several motors designed by Dr. Lovelace, and one will be tested in LEES.

The consortium sponsored three two-day meetings during the past year. One meeting was held in Stuttgart, Germany, co-sponsored by Robert Bosch GmbH. Another meeting, held in Greenville-Spartanburg, South Carolina, and co-sponsored by BMW included a visit to their North American manufacturing site. The third meeting was held in Vancouver, British Columbia, with assistance provided by iQ Power Technology. Approximately 175 people attended each of these meetings. During the next 12 months, meetings are scheduled for Nagoya, Lisbon, and Detroit.

The laboratory successfully concluded its strategic alliance with Ford on accelerating the adoption of a 42 V automobile electrical system standard. A virtual engineering workgroup comprising approximately 25 organizations in 34 different geographical locations worked on the topics of battery connections, jump starting, and energy management. Results of this project were presented in a jointly-authored paper at the *First International Congress: 42 Volt* PowerNet in Austria.

Professor Kassakian co-authored an article on the new automotive electrical system which appeared in *IEEE Spectrum*. He also delivered a keynote address on the application of power electronics in automobile electrical systems at the IEEE Applied Power Electronics Conference.

MODELING, MONITORING AND CONTROL OF POWER SYSTEMS

Utility industry restructuring has placed an intense focus on achieving economically optimal system operation by employing new and more sophisticated control and monitoring strategies. LEES has been making significant contributions to the solutions of problems of power system modeling, economic control, and apparatus monitoring.

Modeling and Control

Professors Bernard Lesieutre and George Verghese, along with several graduate students, have completed one year of a multi-year research effort funded by EPRI and the Department of Defense, and organized in a consortium with Caltech, UCLA and UC Santa Barbara, to study complex interacting networks and systems. The MIT effort focuses on power networks, as well as networks that couple into these, and specifically on problems related to cascading failure in such networks. One very promising outcome of the work so far has been the introduction and elaboration of a so-called "influence model" in the doctoral thesis of graduate student Chalee Asavathiratham, providing a tractable representation for networked Markov chains (e.g. representing transitions between normal, alert and failed states at individual nodes of a network). The influence model is rich enough to capture a variety of interesting behaviors, but tractable because it can be analyzed at successively more detailed levels. Professor Lesieutre has been invited to present the group's work at the IEEE Summer 2000 Power Meeting, and Professor Verghese has been invited to give a one-hour talk on power networks at a workshop on complex networks this summer at the Santa Fe Institute.

Professors Lesieutre and Verghese have also completed an extended research project for Electricité de France on reduction of large dynamic models of power systems, obtaining for the first time reductions by factors of 10 or more in computation time, while preserving satisfactory accuracy. It is anticipated that their Synchronic Modal Equivalencing (SME) framework will find use in dynamic security assessment in utility control centers; initial discussions on this have begun with the national control center in France.

Graduate student James Hockenberry, the first Grainger Fellow supported under a gift from the Grainger Foundation, has completed a project under the supervision of Prof. Lesieutre that demonstrates the feasibility of performing uncertainty analysis on large-scale power systems. He developed a technique for identifying critical uncertainties, which when used with reduced-order modeling methods reduces the necessary computation times by orders of magnitude. This is an enabling technology that allows uncertainty analyses to be performed on these large systems with numerous uncertain parameters.

Professor Verghese and his doctoral student, Christoforos Hadjicostis (now Assistant Professor at the University of Illinois in Urbana), have developed systematic coding-based approaches to the introduction of redundancy for fault tolerance in a variety of computational and dynamic systems. A paper describing the potential application of this to power system monitoring via Petri net embeddings is to appear in the IEE Proceedings, and a monograph growing out of the thesis is to be published this year by Kluwer.

Monitoring of Power Apparatus and Systems

A new method for the early detection of wearout and need for service, which is applicable to power transformers and other oil insulated power apparatus, has been developed by Principal Research Engineer Dr. Chathan Cooke and graduate student Timothy Cargol. The specific goal is the automated in-service detection of degradation of insulating oil used in power apparatus. An operating system has been demonstrated in laboratory studies and will soon be applied on an in-service transformer as a demonstration. Automated operation with automated reporting of troubles to the maintenance department via internet connections make this system especially attractive to new deregulated utilities since it enables maintenance-on-need compared to the present method of fixed time between manual inspections. The automated operation and network communications provide an opportunity for significant cost savings as well as more reliable operations. The work is sponsored by Entergy Services Inc.

In collaboration with Professor Les Norford and post-doctoral associate Steven Shaw, Professor Steven Leeb has demonstrated the first practical field applications of nonintrusive power monitoring technology for diagnostic applications using sophisticated state and parameter estimation algorithms. These techniques permit the identification of energy savings opportunities and equipment failures in building heating and ventilation systems. They are being developed to enhance "green" building operation and to permit the scheduling of maintenance in

advance of critical failures. Field tests have been conducted on and off campus, and will expand to 10 or more new sites in the coming year with funding from the California Energy Commission.

High Voltage and Insulation Research

Dr. Cooke and undergraduate Daniel Santos have begun a new project to reduce the adverse effects of lightning on overhead power transmission and especially the effects on substation apparatus located at the end of a power line. This effort uses a new technique to add a frequency selective loss element that reduces the transient surges at substation apparatus. While existing systems are effective they involve overvoltage arrestors only and are thus limited in their abilities. The addition of a frequency dependent factor to the transient protection results in improved protection and less power outages. Bench size models have been used to demonstrate the method and larger scale tests are being planned.

POWER ELECTRONICS AND ELECTROMECHANICS

Dr. Perreault, along with graduate student Joshua Phinney, has developed a new actively-tuned filter technique for power electronic converters. The new technique allows the use of small notching power filters instead of the bulkier low-pass types that are conventionally employed, resulting in smaller passive component size and reduced converter size, weight, and cost. This new approach is expected to be valuable in a wide range of power electronics applications.

Graduate student Timothy Neugebauer and Dr. Perreault have developed a CAD tool for optimized design of power converters. This new tool has been employed to design a highly optimized dc/dc converter for dual-voltage automotive electrical systems. The optimized converter is less than one quarter the size of previously developed prototypes. Dr. Perreault and Mr. Neugebauer are working with Intronics Corporation to manufacture these converters for use by automotive consortium member companies.

In collaboration with a colleague at Lucent Technologies, Professor Verghese has developed a framework for digital control of paralleled power converters, such as those found in battery plants for telephone exchanges and outdoor base stations. Implementations based on this framework have been crucial to obtaining robust, high performance controllers for the modern battery plants that Lucent currently sells in significant numbers.

Professor Verghese has coedited (with Prof. Soumitro Banerjee of IIT, Kharagpur) an IEEE Press volume on "Nonlinear Phenomena in Power Electronics: Attractors, Bifurcations, Chaos and Nonlinear Control," with contributions from nearly 30 international researchers; the book is to appear later this year.

Professor Leeb and graduate student John Rodriguez are using magnetically triggered gels to develop active vibration dampers. These semi-active dampers have the special property that they can be tuned to damp over a range of vibration frequencies using an applied magnetic field. They can also be made responsive to other environmental stimuli, including light, heat, and the presence of specific chemicals. Successful tuning was demonstrated for the first time this year. Design and experimentation is currently under way to develop dampers suitable for use in transportation applications, e.g., as adaptive, vibration-damping engine mounts in automobiles.

Professor Markus Zahn has recently developed new magnetic field based concepts for realizing nanomotors, nanogenerators, nanopumps, nanoactivators, and other similar nanoscale devices which can be used in new electronic, engineering, biological, and medical applications. This discovery has resulted from his research on magnetic field dependent viscosity in ferrofluids including the possibility of zero or negative effective viscosity. The nano scale of these devices arises from the fact that ferrofluid magnetic particles are of order 10nm in diameter. Proposals on this subject have been submitted to NSF and NASA.

Graduate students Steven Nagle and Luc Frechette, and Professor Jeffrey Lang, in collaboration with colleagues in the MIT Gas Turbine Engine Program, have developed and demonstrated micro-scale electric induction motors for use in micro-scale turbomachinery. These motors exhibit significantly greater torque and power densities, and efficiencies, than do existing electric micro-scale motors.

Graduate student Hur Koser and Professor Jeffrey Lang, in collaboration with Professor Mark Allen and his students at the Georgia Institute of Technology, and colleagues in the MIT Gas Turbine Engine Program have completed the design of micro-scale magnet induction motors and an electroplating process to fabricate them. These motors should exhibit torque densities that are significantly superior to those of existing electric micro-scale motors. Fabrication of the first motor is currently underway, and testing is expected during the next several months.

Graduate student Jo-Ey Wong and Professors Martin Schmidt and Jeffrey Lang have completed their development of a micro electromechanical relay for switching power in low-voltage applications. Their relay, which was demonstrated earlier this year, is electrostatically controllable, and hence it dissipates zero control power in its on state. Its on-state threshold voltage is lower than any other electrostatically-controlled relay, and its on-state current capacity is higher than any other such relay.

INSTRUMENTATION

Tim Denison and Professor Leeb are collaborating with Harvard University and the Rowland Institute to develop circuitry applicable for DNA sequencing and polymer identification. A new pico-amp electrometer has been designed that, in combination with a nano-pore formed in a lipid membrane, has been successfully used for the first time this year for genetic sequence recognition.

PERSONNEL CHANGES

Senior Research Scientist Dr. Marija Ilic has left the laboratory to join colleagues in the Laboratory for Information and Decision Systems (LIDS).

Ms. Kiyomi Boyd has joined the laboratory as Senior Secretary and assistant to the Director. Her fluent Japanese has been a valuable asset as Japanese membership in the Automotive Consortium has grown.

HONORS AND AWARDS

For part of the past academic year Professor Zahn was a ville de Paris scholar and held La Chaire Paris-Sciences at the Ecole Superieure de Physique et de Chimie Industrielle (ESPCI) in France, where he also received the ESPCI medal for Paris Sciences 2000.

Professor Leeb was selected as a Discover Magazine award finalist for his ARCLight fluorescent lamp ballast. This ballast modulates the arc in a fluorescent light to establish an optical data network using conventional room lighting. The technology has been used, among other applications, to provide navigation information to the blind in public venues.

Professor Kassakian received the IEEE Millennium Medal for his contributions to the profession and service to the Power Electronics Society.

John G. Kassakian

LABORATORY FOR INFORMATION AND DECISION SYSTEMS

The Laboratory for Information and Decision Systems (LIDS) is an interdepartmental laboratory for research and education in systems, communication, and control. It is staffed by faculty members, research scientists, postdoctoral fellows and graduate students drawn principally from the Department of Electrical Engineering and Computer Science, as well as the Department of Aeronautics and Astronautics, Mechanical Engineering and the Sloan School of Management. Undergraduate students participate in the research program of the Laboratory through the Undergraduate Research Opportunities Program (UROP). Every year several research scientists from various parts of the world visit the Laboratory to participate in its research programs.

The fundamental research goal of the Laboratory is to advance the field of systems, communication, control, and signal processing. In doing this, it explicitly recognizes the interdependence of these fields and the fundamental role that computers and computation play in this research. Specifically, the work conducted at LIDS falls into several areas. Research in the area of communications, networks and systems includes fundamental work on data networks, information theory and communication theory. Systems research includes satellite communications, wireless communication, optical communications and networks. Research in the area of estimation and signal processing includes work on multi-resolution statistical signal processing, robust estimation in the presence of non-normal noise, and the analysis of large scale systems. Research in the area of control ranges from theoretical issues such as robustness, aggregation, and adaptive control, to the construction of a computer-aided design environment for the control of unmanned air vehicles, the use of neural networks for approximating optimal controller designs and system identification and the study of natural neuro-control systems. Research in the area of algorithms includes analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research, and for applications in communication networks, control theory, power systems, computer-aided manufacturing, as well as such topics as resource allocation and scheduling under uncertainty and neuro-dynamic programming. Research on perceptual systems and machine learning includes the problems of speaker-independent speech recognition, on- and off-line handwritten character recognition.

As an interdepartmental laboratory, LIDS reports to the Dean of the School of Engineering, Thomas L. Magnanti and the director of the laboratory is Professor Vincent W. S. Chan.

The Center for Intelligent Control Systems, an inter-university, interdisciplinary research center operated by a consortium of Brown University, Harvard University, and MIT, resides administratively within LIDS.

Twenty faculty members, several research staff members, and approximately 90 graduate students are presently associated with the Laboratory and the Center. Currently, the Laboratory and the Center provide some 60 research assistantships to graduate students. Undergraduate students also participate in research and thesis activities. A number of postdoctoral and visiting appointments are made.

Financial support is provided by the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), the Defense Advanced Research Projects Agency (DARPA), C.S. Draper Laboratory, Intel, Motorola University Partnerships in Research, the National Science Foundation (NSF), the National Reconnaisance Office (NRO), the Office of Naval Research (ONR), Siemens AG, Tellabs, Inc., and the Multiple University Research Initiative Program (MURI).

The current research activities of the laboratory cover a wide range of theoretical and applied areas in systems, communications, control and signal processing. These areas include the following:

COMMUNICATIONS

Data Communication Networks

The major objective of this work is to develop the scientific base needed to design data communication networks that are efficient, robust, and architecturally clean. Both wide-area and local-area networks, both high-speed and low-speed networks, and both point-to-point and broadcast communication channels are of concern. Some specific topics of current interest are power control, the capacity of wireless channels with parallel relays, splitting and successive decoding for wireless networks, routing in wireless networks, quality of service control, diverse traffic mixes, failure recovery, topological design, and the use of pricing as a mechanism for efficient resource allocation. Professors Dimitri P. Bertsekas, Vincent Chan, Robert G. Gallager, Muriel Medard, Eytan Modiano, Dr. Steven G. Finn, and their students are conducting this research.

Optical Networks

During the last year, Professors Vincent Chan, Bob Gallager, Eytan Modiano and Sunny Siu participated in a 'Next Generation Internet' program funded by DARPA. The focus of the program is to design and prototype the next generation local and metropolitan area access network with orders (up to 4) of magnitude increase in data rate, but at the same time decrease the cost of delivery per bit by approximately the same amount. The network will use multiple wavelengths (colors) to increase capacity and optical devices for routing and switching. One interesting architectural features of the network will be an option for the user of the network to set up direct end-to-end optical flows for future applications with very large transactions (Gigabytes and beyond). The architecture design will culminate in a test network deployed in eastern Massachusetts (LIDS as one of the nodes), with 10 Gbps access rate for users and well over a Tbps capacity. In the future DARPA will connect this test network and others around the country to form SUPERNET as a prototype for the Next Generation Internet. The highlight this year was the demonstration of a 1 Gbps flow from a workstation at MIT to one in Washington DC over a fiber without the need of an electronic repeater. Because of the interdisciplinary nature of the research, LIDS is able to partner with members of LCS (Dr. David Clark), Lincoln Laboratory, AT&T, Cabletron, JDS Fitel and Nortel.

Professor Eytan Modiano was awarded an NSF grant to study mechanisms for providing optical bypass in the Next Generation Internet (NGI). The goal of the research is to use Wavelength Division Multiplexing (WDM) technology together with novel algorithms to reduce the size, cost and complexity of electronic switches and routers in the network leading to a dramatic increase in the traffic capacity that can be supported by the NGI.

Professor Muriel Medard, in collaboration with Professor Steven S. Lumetta of the University of Illinois Urbana-Champaign, has worked in an NGI project funded by DARPA in the area of survivability and reliability in direct access networks. The goal of this project is to provide robust access to optical networks in a way that ensures fault-tolerant communications. Results obtained in this area include capacity efficient restoration, as well as robust routing and protocols for local direct access. More details may be found on the World Wide Web at http://www.mit.edu/people/medard/main.htm.

Satellite Communications And Networking

Professors Vincent Chan, Eytan Modiano and John Tsitsiklis and Steven Finn have been working on a new research project on satellite data communications and networking. A DARPA funded Next Generation Internet Program is started with Motorola and Teledesic as research partners.

In the past, commercial satellite communication systems have always been used for trunking purposes, whereas military satellite systems have been providing direct individual user access for decades. With the launching of several new satellite communications systems such as the Iridium system by Motorola and the Globalstar system by Loral, the commercial sector has started a major new trend of providing economic and ubiquitous communication services to mobile users and users with small earth terminals. There are several proposed systems that will focus on supporting data communications. Inevitably, in the future, these satellite systems will be interconnected among themselves and with other terrestrially based networks to form a multi-purpose integrated heterogeneous network of global extent. With the goal towards a commercially based network, the integration of disparate communication modalities of satellite systems, fiber and wireless networks presents the usual challenges of internetworking such as the creation of gateway functions, routing and QoS negotiations across different network domains and network management and control. Typically, satellite open-air links are different from wired terrestrial links in a number of ways: they have higher bit-error rates, larger propagation delays, and fading due to weather conditions.

Furthermore, space networks typically are limited in resources such as onboard buffers and transmission power. As a result, existing protocols often fail to operate efficiently over air or space links. To efficiently connect space and ground networks the wide disparity in transmission capacity and channel quality that exists between these two segments must be addressed. This gives rise to a range of issues including: space/ground network architectures, the design of efficient end-to-end protocols, quality of service assurance and the design of efficient interfaces between the ground and space portions of the network. With this space/terrestrial network multiple connected, new and interesting dimensions open up for the consideration of efficient routing between users and new and more effective congestion control algorithms. The added property of rich path diversity also permits applications with more robust requirements when exploited properly. The proposed research addresses architecture designs for efficient data communications over an interconnected heterogeneous LEOS/terrestrial-wired-wireless network. We have been concentrating on three main themes that we have identified as areas where significant impact to network performance can be made when efficient designs are applied:

- Adaptive power and rate control techniques for the LEOS systems over time-varying satellite channels to achieve greatly improved (an order of magnitude) data throughputs
- Efficient routing algorithms over a time-varying integrated and heterogeneous global network for maximum resource utilization, especially the space segments
- Efficient congestion control algorithms at the transport and network layers for an integrated satellite/terrestrial network

Codes On Graphs And Iterative Decoding

Professor G. David Forney, Jr. and his student Sae-Young Chung have been studying codes defined on graphs and iterative decoding algorithms, particularly low-density parity-check (LDPC) codes. In joint work with Richardson and Urbanke of Lucent Bell Laboratories, they have devised optimization algorithms with which they have designed LDPC codes that are able to approach the Shannon limit within 0.006 dB and that have implementable decoding algorithms. A number of useful approximate analysis methods have been found. Finally, a new general structure for codes on graphs has been found, called "normal graphs." This structure yields a clean separation of functions in decoding, and some powerful and general duality theorems.

Communication Under Channel Uncertainty

In many applications, e.g., mobile wireless communication and military communication in the presence of jamming, the channel characteristic and the nature of the noise are unknown in the design stage of the communication link. For such applications it is imperative to design robust receivers and codes that allow reliable communication over each of a wide family of channels. To this end Professor Amos Lapidoth is studying universal receivers that do not require precise knowledge of the channel law, and yet perform asymptotically as well as the best receivers that could have been designed had the channel been known in advance. Professor Lapidoth is also studying the ultimate bounds on the rates at which reliable communication can be guaranteed over a channel that is only known to belong to some given family of channels.

Professor Medard has been investigating several issues in the area of wireless communications over uncertain channels. In collaboration with Professor R. Srikant at the University of Illinois Urbana-Champaign, she has investigated the effect of unequal channel knowledge at the sender and receiver. In particular, they have developed bounds to assess the effectiveness of applying techniques designed for certain idealized channel models to more channels with more detailed models. In collaboration with Professor Andrea J. Goldsmith of Stanford, she has investigated the capacity of time-varying channel with sender and receiver side information, in particular for channels with perfect side information but significant inter-symbol interference, for which no capacity formulas existed.

Wireless Communications

Professor Robert G. Gallager together with several students, have ongoing projects in mobile communication aimed at developing a cohesive theory and set of insights for wireless multiple access. Specific research includes the capacity of fading channels, the transmission of bursty sources over a shared time-varying channel, transmitter power allocation across many cells, and capacity improvements through joint decoding.

Professor Muriel Medard has worked in the area of developing capacity models for wireless channels. With Professors Sean Meyn of the University of Illinois Urbana-Champaign and Professor Andrea Goldmisth, she has worked on defining capacity regions for time-slotted packetized access for uncoordinated users sharing a single channel.

Collaboration With Tellabs

The Laboratory for Information and Decision Systems and Tellabs Operations, Inc., a telecommunications equipment manufacturer, are developing a novel approach to collaborative research. In this approach, LIDS and Tellabs integrate industrial research interests within MIT's research and educational environment. The key difference between this new model of collaboration and traditional approaches is the focus on human resources as the primary enabler. Toward this end, LIDS provides Tellabs with access to faculty, students, visitors, facilities, and infrastructure support, while Tellabs dedicates resident corporate research positions to the effort, assuming responsibility both for co-advising students research and for technology transfer as an internal corporate process. LIDS benefits from the persistent presence of industrial researchers, and Tellabs benefits from the leveraging of LIDS's staff. LIDS and Tellabs have been jointly working on this new research model for three years and look forward to its growth and refinement.

SYSTEMS, DETECTION, ESTIMATION AND OPTIMIZATION

Stochastic Systems Group

The Stochastic Systems Group (SSG) is led by Professor Alan S. Willsky, with the assistance of Research Scientist, Dr. John Fisher. In addition, the group includes 10-12 graduate students, several postdoctoral researchers (currently 2), visitors, and participants from other groups within LIDS and from other MIT laboratories and departments. The general focus of research within SSG is on the development of statistically-based algorithms and methodologies for complex problems of information extraction from signals, images, and other sources of data. The work in the group extends from basic mathematical theory to specific areas of application. Current applications include SAR-based automatic target recognition (ATR), biomedical image analysis, oceanographic and hydrological data assimilation, and situation modeling for complex phenomena (such as military situations). Funding for this research comes from a variety of sources, including ONR, AFOSR, ARO, DARPA, ODDR&E (through AFOSR, ARO, and ONR), NIH, and NSF.

In addition to directing these research activities, Professor Willsky is very active in supporting government and, in particular, DoD organizations in assessing and planning technology investments. In particular, he is a member of the Air Force Scientific Advisory Board. Each of the following research areas being pursued within SSG involves both theoretical development as well as applied studies to the application areas mentioned previously.

Multi-Resolution Statistical Signal Processing

For some time now (and in part sparked by the flurry of activity associated with the wavelet transform) there has been considerable interest in algorithms for processing signals or images at multiple resolutions. SSG has played a leadership role in developing a statistical basis for such multiresolution processing that has had a significant impact as evidenced not only by the applications pursued within the group (in SAR-based ATR, oceanography and hydrology, and computer vision, for example) but also by the increasing use of our methodology by others in fields ranging from biomedical imaging to chemical engineering to helioseismology.

The key to this research area is the direct statistical modeling of phenomena at multiple resolutions using graphical models on trees, in which each level on a tree corresponds to a particular resolution. We have developed very efficient algorithms for estimation, data fusion, and other image analysis tasks using these models and have also demonstrated, primarily through example and application, that a wide variety of real phenomena and applications can be captured within this framework. Because of this success, our current and planned efforts involve expanding the domain of applicability of our methodology, both by pursuing additional applications and by developing tools for constructing multiresolution models needed as the basis for applying our results. In particular, we have recently had several important new results that allow us much more easily to construct multiresolution models for complex phenomena.

Most recently we have increased our investigation on how we can exploit our methodology for problems involving much more complex graphical models as arise in military command and control or in problems of monitoring complex systems, a problem of great national concern because of its relevance to making critical national infrastructure secure. In particular our approach to modeling takes a very different perspective from most work on graphical models—in particular, we focus explicitly on developing accurate but approximate models that have structure that leads to very fast optimal algorithms, rather than most work on graphical models that involves trying to find tractable suboptimal solutions to exact graphical models that do not have structure that allows fast optimal inference. Recently we have had a significant breakthrough in this area, using our tree-based algorithm as the control component in algorithms for graphical models on graphs other than trees.

Nonlinear and Geometric Image Analysis

During this past year, we have continued our efforts in the area of nonlinear/non-Gaussian image analysis, including the explicit estimation/extraction of geometric information such as object boundaries and segmentation. The first part of our work in this area involves the development of statistically-based curve evolution algorithms. Such algorithms involve explicitly defining and dynamically evolving curves in ways that lead to accurate and efficient segmentation of images. Methods of this type that had been developed by others had a number of very attractive features, including the fact that they provided seamless ways in which a curve could separate into multiple curves or merge from several disjoint curves to a single curve, allowing automatic and easy segmentation of multiple regions of interest (e.g., multiple blood cells in a microscopic image). However, previously developed methods either were very sensitive to noise or required ad hoc preprocessing to remove noise but that also reduced the resolution of the resulting segmentation. In our work, we have developed a first principles statistical approach to curve evolution that deals with noise and variability in a statistically optimal way without sacrificing resolution. The resulting suite of

algorithms that we have developed have shown great promise for the analysis of a wide variety of imagery of varying quality and contrast. In particular, in addition to continue our work on extending our methodology we are also actively involved with clinicians and researchers at Brigham and Woman's Hospital who are pursuing the development of image guided therapy procedures for prostate cancer.

Finally, we have continued our work on developing non-Gaussian multiresolution models for images that capture more faithfully the scale-to-scale variability observed in real images. In particular, real images have what are commonly referred to has "heavy-tailed" statistical behavior which is not captured by Gaussian distributions. We have now constructed a rich class of models that both captures the behavior of real imagery and also leads to very efficient and robust image processing algorithms.

Information-theoretic Methods in Image Analysis and Fusion

During this past year, we have continued to increase our efforts in developing and using methods of non-parametric statistics for a variety of very complex image analysis and fusion problems. In particular, in our work on SAR-based ATR we have built non-parametric probabilistic models that capture statistically significant differences in the scattering response of different types of scatterers and then using these models to exploit these differences for feature extraction, enhancement, and recognition. We have also used non-parametric statistics together with the concept of mutual information to develop new approaches for functional MRI studies in which we wish to correlate particular experimental protocols (e.g., a patient squeezes and then releases a ball) with brain activity so that mapping of brain activity to function can be performed. This work is interesting in that it involves fusing information of very different modalities (force applied to a ball and Magnetic Resonance Imagery). We have also used similar tools for the fusion of video and acoustic data and, in particular, for the localization of the sources of sound (e.g. human voices) in the video field of view.

Radar-Based ATR

Professor Shapiro and his students have been working on several physics-based approaches to ATR problems, focusing on the important area of performance assessment. Their work has included analysis of the benefits of adaptive-resolution processing in synthetic-aperture radar (SAR) systems used for target detection and recognition. They have also established an analytical framework for determining the accuracy with which the orientation of a ground-based target may be estimated from forward-looking infrared (FLIR) and laser radar (LADAR) imagery. This study is being extended to a predict the detection and recognition performance limits of these two sensors. In both the orientation, estimation and detection/recognition contexts the performance gains that accrue from sensor fusion are being quantified. In all of this work, the principal objective is to replace simulation and/or train-and-test performance assessments with more analytical techniques which allow the interrelated effects of sensor parameters, target signatures, and atmospheric propagation on system performance to be determined and understood.

Nonlinear System Analysis And Designs

Professor Alexandre Megretski and his students are working on the development of new methods of nonlinear system analysis, and application of these techniques in various control systems, (flight control, firm control, animation control, hybrid systems, etc.). The work involves a broad spectrum of system-theoretic topics including modeling, identification, stability analysis, and optimization. One important objective is to learn how simplifications necessarily made in nonlinear system modeling affect the validity of nonlinear control design.

Neurobiological Modeling

Professors Dahleh and Massaquoi are interested in two problems. The first is the development of a hierarchical model of the interaction between the cerebrum and cerebellum that is anatomically justified that can explain two-dimensional arm motions. The second problem is deriving a multi-scale, multi-resolution model that explains EEG data, with specific interests in Anesthesia. These projects are in collaboration with various laboratories/departments at MIT as well as the Massachusetts General Hospital and the Brockton V.A. Medical Center.

Algorithms

This project focuses on analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research, as well as for applications in communication networks, control theory, power systems, computer-aided manufacturing, and other areas. Currently, in addition to traditional subjects in nonlinear and dynamic programming, there is an emphasis on the solution of large-scale problems involving network flows, as well as in the application of decomposition methods. Professors Dimitri P. Bertsekas and John N. Tsitsiklis and their students perform this work.

Neurodynamic Programming

Problems of sequential decision making under uncertainty are all pervasive; for example, they arise in the contexts of communication networks, manufacturing systems, logistics, and in the control of nonlinear dynamical systems. In theory, such problems can be addressed using dynamic programming techniques; in practice, however, only problems with a moderately-sized state space can be handled. This research effort deals with the application of neural networks and other approximation and interpolation methodologies to overcome the curse of dimensionality of real-world stochastic control problems. The objectives driving this research are twofold. First, to develop the theoretical foundations and improve the understanding of such methods, using a combination of tools from approximation theory, dynamic programming, and stochastic algorithms. Second, to use these methods for solving some large-scale problems of practical interest. Application areas being currently investigated include problems in logistics (resource scheduling and assignment), finance (pricing of high-dimensional derivative instruments, dynamic portfolio management in the presence of risk constraints), supply chain management, and communications (dynamic channel allocation). Professors Dimitri P. Bertsekas and John N. Tsitsiklis and their students perform this work.

Perceptual Systems

Sanjoy Mitter, Stefano Casadei and their collaborators have been working on various aspects of Perception and Recognition. Perception and recognition consist in recovering useful information about the environment from sensed data and prior knowledge about the real world and the sensors. Artificial systems designed to carry out this task are yet much inferior to biological systems, largely due to the size and intricacy of the knowledge required to carry out reliable inference in unrestricted and uncertain domains. For instance, in visual perception, several factors contribute to render the problem difficult: clutter, occlusion, and variability of the objects in the scene. The basic engineering principle of decomposing a complex task into simpler and independent tasks is difficult to apply to perception and recognition due to the extremely complicated and yet unknown pattern of interdependency among the many "acts of perception" involved. For instance, the recognition of an occluded chair in a cluttered office environment is highly dependent on the interpretation of its subparts, the other objects near to it and the overall scene of which it is part.

What are the components, which are involved in perception and recognition? What architecture should these components to be organized into? How does one minimize the interdependence of these components? How should uncertainty be represented? How does one acquire and represent the knowledge about the real-world and the sensors? Several projects are being undertaken to find answers to these questions.

- Work in character recognition initiated several years ago is currently being extended to handwriting recognition and signature verification.
- A hierarchical approach to contour estimation is being developed by adding more general models of object contours to the hierarchy. The current edge model being worked on includes illusory contours and curve singularities (corners and junctions) but is limited to convex closed contours.
- Non conventional probabilistic approaches, such as De Finetti's theory of probability, are being explored to represent uncertainty without resorting to the introduction of artificial priors. In this context, the relationship between set-based models of uncertainty and the probabilistic approach are being studied.
- A new computational theory for the recognition of occluded deformable templates in a cluttered scene has led to efficient algorithms with guaranteed performance in terms of localization errors and time complexity. Currently, this approach has been applied to features consisting of points in the plane and to affine deformations. Future work will seek to generalize these assumptions.
- Early recognition of moving ground targets from an approaching platform is an important task for the military. To enhance the performance of existing systems, it is necessary to combine information from multiple frames, which contain the target at different resolutions. This project is still at an early stage and initial efforts have focused on the incorporation of continuity and smoothness constraints of the relative motion of the target with respect to the camera by means of a geodesic approach.

Electric Power Systems

Dr Marija Ilic, together with her 10-12 graduate students and several international visitors, is currently working on new concepts for planning and operating electric power systems under restructuring. These range from: modeling and simulation of the electricity market dynamics; new control paradigms for distributed monitoring, estimation and decision making over time horizons relevant for reliable operations as well as for dynamic investments under uncertainties; and through modeling, simulation and control of large transmission grids required to provide open access to all market participants. This work is closely coupled to industry through the "Consortium on New Concepts and Software for the Electric Power Industry under Restructuring," which is administered through the Energy Laboratory and currently has five members. The problems of immediate solution needs concern congestion

control using technical feedback as well as incentive pricing. These are challenging examples to the state-of-the-art in the hybrid control of large dynamic systems, decision making under uncertainties and approximate dynamic programming.

Dr. Ilic recently published jointly with Professor John Zaborszky a textbook entitled "Dynamics and Control of Large Electric Power Systems," which could be used by people interested in applications of systems and control theories to the electric power systems. Dr. Ilic also participates in an EPRI/DoD sponsored multi-university project on complex interactive networks as part of the Harvard led team. She has spent 1999–2000 school year as a Control, Networks and Computational Intelligence (CNCI) Program Director at the National Science Foundation on half time basis.

CONTROL

Multivariable And Robust Control

The systematic design of multiple-input, multiple-output systems, using a unified time-domain and frequency-domain framework to meet accurate performance in the presence of plant and input uncertainty is an extremely active research area in the Laboratory. Various theoretical and applied studies are being carried out by Professors, Munther A. Dahleh, Gunter Stein, Steve Massaquoi and their students. Theoretical research deals with issues of robustness, aggregation, and adaptive control. The aim of the research is to derive a computer-aided design environment for the design of control systems which can address general performance objectives for various classes of uncertainty. Furthermore, new results on the robustness of nonlinear feedback systems, using feedback linearization, have been obtained for unstructured uncertainty model errors. Recent application-oriented studies include the control of large space structures, helicopters, submarine control systems, issues of integrated flight control, control of chemical processes and distillation columns, automotive control systems, and the modeling and analysis of biological control systems.

New areas of application of robust control theory are now emerging at LIDS, including the real-time, agile guidance of single and multiple Unmanned Aerial Vehicles (UAV) as well as vehicle anticollision problems arising in Air Traffic Control. Some of these concepts are implemented and tested on small helicopter systems. Professors Feron and Massaquoi are beginning a collarboration regarding the brain's internal representation of external world dynamics.

Feedback Control Using Approximate Dynamic Programming

Feedback controllers for nonlinear systems are often driven by potential (Lyapunov) functions, whereby the controller at each step steers the system in a direction of decrease of the potential function. The optimal cost-to-go function that results from dynamic programming formulations of control problems is a suitable such Lyapunov function, except that it may be difficult to compute. This research investigates whether recent approximate dynamic programming methods, that rely extensively on simulation and neural network training, can lead to a viable methodology for designing Lyapunov functions and controllers for nonlinear feedback systems. This research is carried out by Professors Munther A. Dahleh and John N. Tsitsiklis, and their students.

Identification And Adaptive Control

Determining the fundamental limitations and capabilities of identification and adaptive control is an active area of research, carried out by Professors Munther A. Dahleh, John N. Tsitsiklis, and their students. This research program draws upon areas such as information-based complexity theory and computational learning theory, as well as upon the theory of robust control. One aim of this research is to develop a theory that combines both system identification and robust control within the same framework, in which a controller that meets given performance specifications can be designed based on finite noisy data. Issues studied include the representation of uncertainty in both noise and model, design of experiments, sample and computational complexity, as well as implementation of optimal algorithms.

Computational Complexity

Problems in systems and control theory are of varying degrees of difficulty, ranging from polynomial-time solvable to undecidable. Professor Tsitsiklis and coworkers have been using tools from theoretical computer science (theory of computation) to characterize the intrinsic difficulty of problems in stochastic optimal control, and various stability problems for hybrid systems, saturated linear systems, and linear time-varying systems.

Control In Presence Of Communications Constraints
Sanjoy Mitter in collaboration with Vivek Borkar (Tata Inst. of Fundamental Research, India), Nicola Elia and several graduate students have been working on fundamental issues of control in the presence of communication constraints. The goal of this research is to understand the interaction between information and control in the presence of uncertainty. Development of Real-time Information Theory forms an essential part of this research topic.

Unmanned Air Vehicles
Professors Dahleh and Feron with their students have been working on developing control architectures for unmanned vehicles. This research entails the development of a hierarchical control system that replaces the human pilot in order perform agile maneuvers. The group is also involved in building and demonstrating these concepts on a small helicopter.

Control Of Hybrid Systems
Hybrid systems are compositions of continuous systems (described by ordinary differential equations) and discrete systems that are event-driven. A theory of optimal control of such systems, based on the theory of impulse control and piecewise-deterministic processes, has been developed by Professor Sanjoy K. Mitter in collaboration with Professor Michael Branicky, currently at Case Western Reserve University, Professor Vivek Borkar, visiting from the Indian Institute of Science, and Dr. Nicola Elia, a post-doctoral scientist. Numerical methods for the dynamic programming inequalities arising out of the optimality conditions for these systems have also been developed. Incorporation of the model in the simulation package OMULA/OMSIM has been undertaken in joint work with Prof. Astrom and his group at Lund, Sweden. Professor Mitter has been working with Professors Borkar and Chandru of the Indian Institute of Science, Bangalore on solving questions and problems in logic using mathematical programming. It is planned to unify this work with the previously mentioned work on Hybrid Systems.

Center For Intelligent Control Systems
The Center for Intelligent Control Systems (CICS) combines distinguished faculty from MIT, Harvard University, and Brown University in interdisciplinary research on the foundations of intelligent machines and intelligent control systems. Established in October 1986, CICS is headed by Professor Sanjoy Mitter, Director; Professor Roger Brockett, Harvard University, Associate Director; and Professor Donald McClure, Brown University, Associate Director. The research activities of the Center are loosely grouped in five areas: Signal Processing, Image Analysis, and Vision; Automatic Control; Mathematical Foundations of Machine Intelligence; Distributed Information and Control Systems; and Algorithms and Architectures. A number of outstanding graduate students are appointed Graduate Fellows. The Center also hosts several senior visitors for varying lengths of time each year.

HIGHLIGHTS
Speakers in the LIDS Colloquium and Seminar Series included: Professor Shankar Sastry, University of California, Berkeley, Professor John Tsitsiklis, LIDS, MIT, Professor Sassam Bamieh, University of California, Santa Barbara, G. David Forney, Bernard M. Gordon Adjunct Professor, LIDS, MIT, Professor Bin Yu, University of California, Berkeley, Lucent Technologies Bell Labs, Professor Karl J. Astrom, Lund Institute of Technology, Sweden, Dr. David Clark, LCS, MIT, Professor Eytan Modiano, LIDS and Aeronautics and Astronautics, MIT, Professor Stephen Boyd, Stamford University, Professor Jose M. F. Moura, Carnegie Mellon University, Dr. Debasis Mitra, Bell Laboratories/Lucent Technologies, Dr. Nigel Newton, Essex University, Colchester, England, Professor Steven Pinker, Brain and Cognitive Sciences, MIT, Dr. Richard Barry, Chief Technology Officer, Sycamore Networks, Jeffrey P. Sutton, M.D., Ph.D., Massachusetts General Hospital, Harvard-MIT HST, Professor Bhubaneswar Mishra Courant Institute, New York University, Professor Jay W. Forrester, Sloan School, MIT, Professor Kack Keil Wolf, University of California, San Diego, Professor Dimitris Bertsimas, Sloan School, OR & LIDS, MIT, Dr. Hans-Andrea Loeliger, Endora Tech AC, Switzerland, Professor Anthony Ephremides, University of Maryland, Professor Pramod P. Khargonekar, University of Michigan, Professor Kameshwar Poolla, University of California, Berkeley, Fred Baker, Fellow, Cisco Systems, Chair, Internet Engineering Task Force.

Visitors to the Laboratory for Information and Decision Systems included Professor Jose M. F. Moura, Carnegie Mellon University; Dr. Nigel Newton, Essex University, Colchester, England; Professor Vevek Borkar, TATA Institute of Technology, India; and Dr. Roberto Segala, University of Bologna, Italy.

Robert G. Gallager Elected Fellow of IEC, June 6, 2000, awarded IEEE Millenium Medal, 2000.

Professor John Tsitsiklis was the plenary speaker at the Fourteenth International Symposium of Mathematical Theory of Networks and Systems, Perpignan, France, June 2000.

Alan Willsky has been appointed the Edwin S. Webster Professor of Electrical Engineering.

Vincent Chan

LABORATORY FOR MANUFACTURING AND PRODUCTIVITY

The Laboratory for Manufacturing and Productivity (LMP) is an interdepartmental laboratory in the School of Engineering with three major goals: the development of the fundamental principles of manufacturing systems, processes, and machines; the application of those principles to manufacturing enterprises; and the education of engineering leaders. With 11 faculty and senior research staff and 70 graduate students, the laboratory conducts research in the areas of design, analysis, and control of manufacturing processes and systems.

This research is conducted through industrial consortia, sponsored research projects, and government grants. LMP's major areas of interest include: Production System Design, Precision Engineering, Three Dimensional Printing, Rapid Autonomous machining, Reconfigurable Tooling, Droplet-Based Manufacturing, Automatic Identification, Continuous Casting Monitoring, Machine Elements and Systems, Tribology , Microcellular Plastics, and Composites Manufacturing. In addition LMP works closely with the Materials Processing Center, the Leaders for Manufacturing Program, and the Lean Aerospace Initiative. Many of our research projects are also with individual companies. In total, the laboratory works with about 50 different companies worldwide. Our government support comes from a variety of agencies including; DOD, NSF, NASA and DOE, and is often coordinated with industrial support.

The Laboratory for Manufacturing and Productivity enjoyed an excellent year in 1999–00 with a research volume of $3.7 million. A few projects contributed disproportionately to this volume. These included the work of Professor Ely Sachs (3D Printing), Professor David Cochran (Production Systems Design), Professor Sanjay Sarma (Automated Manufacturing) and Professor David Trumper (Precision Engineering).

The Laboratory for Manufacturing and Productivity hosted an international symposium whose theme was exploring New Manufacturing Processes and Systems entitled "The Future of Manufacturing: New Development in Technology and System Design" on April 18 and 19, 2000, at the University Park Hotel in Cambridge. It was attended by participants from industry and academia from many parts of the world.

RESEARCH AND EDUCATION HIGHLIGHTS, AWARDS

In the past year we have seen the creation of the 1200 sq. ft. Ralph E. Cross CAD/CAM Instructional Classroom and Laboratory, which will provide state-of-the-art, hands-on experience linking the CAD/CAM System and the CNC tools within the LMP machine shop. Significant new and/or continuing research programs were funded, and several new educational initiatives were started. In addition our faculty and staff continue to be honored with awards and recognition by their colleagues

Professor David Cochran's successful new program in Production System Design continues to grow at a significant rate. This program has captured important new funding from industry, including major new funding from Ford at several sites, in the area of "Lean, Cellular Manufacturing System Design." In addition Professor Cochran's two new courses in production system design at both the undergraduate and the graduate level, 2.812 and 2.82 have been greeted with enthusiasm by our students. These courses allow students to develop manufacturing systems at local Boston area manufacturers.

This year Professor Sanjay Sarma, the Cecil and Ida Green Career Development Professor founded the Auto-I.D. Center with his colleagues, Dr. David Brock and Professor Kai-Yeung Siu. The center's mission is to create an intelligent infrastructure to connect physical objects to the internet and to each other. Professor Sarma was recognized for his teaching and research contributions through early promotion to Associate Professor.

Professor David Trumper who was honored by ASME with the Leonardo D'Avinci Award and was honored by MIT with the Spira Award for Excellence in Teaching has developed a new high speed lathe for turning asymmetric parts. In the last year, Professor Trumper has been promoted to Associate Professor with tenure. His research has continued in high-speed motion control for rapid production of ophthalmic lenses using a novel fast tool servo, and in magnetic suspension of flexible workpieces for noncontact processing such as heat treatment, coating, or painting. His group has also started a new project to develop novel hybrid axes for meso-scale machining. An initial application of the developed technology will be for the rapid production of dental restorations. Professor Trumper has continued to develop his courses in Digital Control and Mechatronics.

Professor Ely Sachs, whose 3-D Printing and related activities continue to lead in the laboratory, has received several new research awards: Three Dimensional Printing and Integrated Ceramic Components for Electronics, Three Dimensional Printing of End Use Metal Parts with Fine Powers, and Prototyping and Manufacturing of Cutting Tool Inserts by 3D Printing. In addition he continues his work in the following areas: Design Automation, Low-Cost, High Performance Tooling by 3D Printing, Structural Materials by 3D Printing, Three-Dimensional Geometry Generation by 3D Printing, Automotive Tooling for Casting, as well as the Distributed Design and Fabrication of Metal Parts and Tooling by 3D Printing. Currently Professor Sachs is serving as a designated Professor for the department of Mechanical Engineering with responsibility to revise and integrate the undergraduate teaching of Design and Manufacturing. In addition, Professor Sachs is developing a new important course on the Development of Manufacturing Processes and Equipment (2.815).

Professor David Hardt has taken a principal leadership role as liaison faculty in manufacturing to the MIT/Singapore Alliance and to the concept of distance learning in general. He has developed an MEng in Manufacturing degree program for Singapore, which will be a highly integrated set of courses that cover topics from processing, equipment, automation, process control, systems and product design as well as basic business issues. These courses are being delivered in Singapore by MIT faculty in July 2000. Later, a revised version will likely be offered to MIT students as well. In addition, Professor Hardt has recently successfully demonstrated his research on Reconfigurable Tooling for Rapid Response Forming of Aerospace Structures to industry.

Professor Alex Slocum, who was honored by MIT last year as the Martin Luther King Outstanding Faculty Member for his work mentoring minority students and was chosen to be one of four MacVicar Fellows at MIT for 1999–2000, is currently on sabbatical.

Professor Jung-Hoon Chun who is the Co-Director of the Manufacturing Institute is responsible for developing several new projects with Korea and SVG. Professor Chun has also received funding from NSF on Micro-Droplet Deposition in Droplet Based Manufacturing (DBM). This work has led to a significant new process for electronics packaging with 7 worldwide licensees. In addition, other applications of DBM are being licensed in such areas as metal tooling, rapid prototyping, metal injection molding and thermal spray coating applications. He also continues to develop his new "CASTSCAN" Program based on high-energy X-ray tomographic imaging. The focus of the program is to study the mold filling process for lostfoam casting for automotive applications. His undergraduate course on Engineering Management, which is very successful, has recently been expanded to including graduate students. In addition Professor Chun is very active in the Singapore-MIT Alliance. This summer he delivered a new course in Singapore.

Dr. Stanley B. Gershwin who is the Associate Director of the LMP recently became a Fellow of the IEEE for "pioneering work and leadership in the development and implementation of system and control approach to manufacturing." Dr. Gershwin has received continued support and new awards in several important areas of design and operation of manufacturing systems including "Wafer Fab Operation Models,: Analysis, and Design and Distributed" and "Collaborative Supply Chain Decision Making in Electronic Commerce."

Professor Samir Nayfeh is developing significant new research in precision machine design, mechanical power transmission, machine dynamics, and control. He is initiating an effort to develop the automated factory of the future following the open-source model that has been so successful in the complex software that holds the Internet together.

Professor Nam Suh was honored this year by the Royal Institute of Technology, Stockholm, Sweden 2000, with a Doctor H.C. He continues to lead the international development of the field of axiomatic design and this year published "Axiomatic Design: Advances and Applications" by the Oxford University Press.

This year Professor Timothy Gutowski served as panel chairman for an NSF/DOE sponsored effort to investigate Environmentally Benign Manufacturing worldwide. He offered a new graduate course entitled, "Manufacturing Systems and People" and he continues his research on composite materials.

Timothy G. Gutowski

LEADERS FOR MANUFACTURING PROGRAM

The Leaders for Manufacturing (LFM) Program is a partnership between MIT and over 25 global manufacturing firm to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now in its twelfth year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students both as fellows in the program (with fully-paid tuition) and as research assistants throughout the Institute. The largest component of the educational efforts is the Fellows Program, a 24-month dual-masters degree (engineering and management) experience involving a single integrative research project carried out on site in partner firms.

ACADEMIC PROGRAM

Forty-eight students in the class of 2000 completed the Fellows program and 66% have taken positions in manufacturing firms. Twenty-eight students have taken positions with one of the LFM partner companies. Intel was notable for a large number of hires from the class.

Each of the forty-eight graduates completed an internship at a partner company during the summer and fall of 1999. Internships are focused projects of concern to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included the launch of a Ford production IT system; applying lean manufacturing principles to a virtual business; and implementing a kanban card for a manufacturing plant, which reduced inventory, streamlined the products' material flow, and resulted in a $50,000 savings.

Forty-eight students (Class of '01) completed their first year of on-campus studies and are starting their 6-month internships. Forty-seven new students (Class of '02) were admitted and have begun an intensive summer session. All of these students have an average of approximately 5.3 years of practical work experience.

Bea Mah Holland, who holds the position of Director of Leadership for the Sloan School and LFM, officially joined MIT full-time early in FY2000. She has significantly increased activity in the classroom about the concept of leadership and what it means for industry.

RESEARCH AND KNOWLEDGE TRANSFER PROGRAM

Research has been conducted with seed funding from LFM in the following areas: Product Life Cycle Analysis, Scheduling and Logistics Control, Variation Reduction, Design and Operation of Manufacturing Systems, Integrated Analysis and Product Development, Culture and Organizational Change, and the Next Generation Manufacturing project. Each area has both a faculty and an industry leader. The groups focus on detailed issues of benefit to several member companies, but with implications for many companies. On-site student interns have played a valuable role in teaming with on-campus researchers to more effectively define problems, gather data, and analyze it. Midstream and end-of-internship presentations convey research results to MIT and partner company personnel. This past year the Integrated Supply Chain Management partner companies participated in the scheduling and logistics presentations.

The three-year study, "The Utilization of LFM Graduates," conducted by Jan Klein, Senior Lecturer in the Sloan School of Management, includes research findings of interviews with alumni, supervisors, and managers from each company that has utilized LFM graduates and students. These companies include ALCOA, Boeing, Chrysler, Compaq (formerly Digital), Kodak, Ford, GM, HP, Intel, Motorola, Polaroid, and UTC. This past year the study was expanded to include MIT faculty, which resulted in the interviewing of over fifty MIT faculty.

LFM now provides all LFM theses in a word search format at http://lfm.mit.edu/.

OUTREACH

The National Coalition for Manufacturing Leadership (NCML), a partnership of fourteen Universities with joint management and engineering programs, hosted a joint recruiting forum (the National Manufacturing Recruiting Forum) sponsored by the University of Michigan. Over two hundred students and seventy companies participated in

this event. LFM made a significant contribution to the NMRF by developing a robust, web-based interview scheduling system that increased interview scheduling efficiency and was applauded by students and companies alike. The NMRF has been very popular with Coalition partner companies and will be repeated each year. Representatives from the Coalition meet each year to share curriculum, research, and program best practices.

PLACEMENT

Class size: 48 students

(10 Partner Company sponsored students; 1 non-Partner Company sponsored student; and 37 non-sponsored free agents.)

	# Hired	**% of Class**
Partner Companies	28	58
Other Mfg. Companies	4	8
Total Manufacturing	32	66
Consulting/Banking	6	13
Other Operations	3	6
Other	7	15
Total employed graduates	48	100
Free agents hired by Partner Companies	19	40

Students accepted positions with the following companies:

LFM Partner Companies: ABB, Alcoa, Boeing, Dell, Eastman Kodak, Eaton, Ford, GM, Honeywell, HP, Intel, Motorola, UTC.

Other Mfg. companies: Johnson & Johnson, Medimmune, Nippon Stryker, Valeo.

Consulting/Banking: Bain, BCG, Diamond Technology Partners, Goldman Sachs, McKinsey, PRTM.

Other Operations: Amazon.com, BellSouth Corporation, IronRhino.com.

Other: iCompass, I2 Technologies, Jinni Inc., Maxager Technology, Syncra Systems, Inc., Ten Fold.

William C. Hanson

MATERIALS PROCESSING CENTER

The Materials Processing Center (MPC) is an interdisciplinary center within MIT's School of Engineering. It is directed by Professor Lionel C. Kimerling. It was established in 1980 in response to a recognized national need to improve the materials processing knowledge base and streamline the process of translating materials research results into industrial innovations and new products. MPC research covers a broad range of materials and processes focused on six basic industrial sectors: biomaterials, primary materials, structural materials, electronics and microphotonics, transportation, and energy. We measure the value of this research by its impact on commercial and defense applications.

The mission of the Materials Processing Center is to provide an environment where students and professionals from industry, government, and academia collaborate to identify and address pivotal multidisciplinary issues in materials processing and manufacturing in a way that creates new knowledge, produces knowledgeable and capable employees, and promotes the exchange of information in the service of our nation and in the context of a global community.

Because of the interdisciplinary nature of the field of materials processing, faculty and research staff affiliated with the MPC come from a range of fields beyond the traditional materials science and engineering group. Significant contributions to the materials processing knowledge base within the MPC are being made by specialists in the Departments of Chemical Engineering, Chemistry, Electrical Engineering, Mechanical Engineering, Biology, Physics, Aeronautical and Astronautical Engineering, Nuclear Engineering, and Ocean Engineering. MPC research involves approximately 160 faculty, research staff, and visiting scientists, as well as their associated collaborators and graduate and undergraduate students.

In keeping with MIT tradition, the MPC is founded on close ties with industry. We have a 43-member Industrial Collegium of domestic and international companies. For members, the Industrial Collegium serves as a window on the state-of-the-art in materials research and development at MIT. For MIT faculty, the Collegium is a viaduct, bringing their research results to industry attention. In this way, the Collegium provides a technology transfer pathway between university research and industrial application. Part of our strategy is to leverage core federal research funding into expanded industrial-academic collaborations. MPC industrial support currently stands at 36% of our total budget.

HIGHLIGHTS

The MPC initiates programs to enhance the intellectual vitality of the materials processing community at MIT. We measure the value of these programs by the intellectual core they create, by the new and creative collaborations among researchers in diverse departments they catalyze, and by the meaningful research they generate. In October 1999, we held our 4th annual Materials Day at MIT. This program includes a workshop, a poster session with cash prizes given to the best of 61 graduate presentations, and a dinner with our students, faculty, and industrial guests. The day's theme and title was "Small-Volume Structures, Thin Films, and MEMS: Processing and Properties," and the workshop was chaired by Professor Subra Suresh, who later became Head of the Department of Materials Science and Engineering. For miniature structures, issues of production and of the size-dependence of properties and performance are of major technological concern for industries depending on microelectronics, micro-electromechanical systems (MEMS), thin-film coatings, and magnetic storage devices. Materials Day '99 highlighted the unique intellectual breadth and depth of or interdisciplinary materials community and its focus on industrial applications. Materials Day 2000, scheduled for October 16, 2000, will be co-chaired by Professor Douglas Lauffenburger, Co-Director of the Division of Bioengineering and Environmental Health, and by Professor Robert Cohen of the Department of Chemical Engineering. The upcoming Materials Day will explore "Growing Opportunities: Where Materials and Biology Converge."

The MPC sponsors three research-funding initiatives: the MPC Visiting Scholar Program, the MPC Young Faculty Seed Program, and the MPC Research Initiative Seed Program. In the Research Initiative Seed Program, the MIT Solar Club was awarded another year of $5000 in seed funding, and the MPC has welcomed new faculty members Richard Smith, Christine Ortiz, Yoel Fink, Alexander van Oudenaarden, and Adam C. Powell IV to our materials community.

MICROPHOTONICS CENTER

During 1999 the MPC birthed the new Microphotonics Center, and remains the temporary host to this daughter Center. The Microphotonics Center is supported by a 17-member core faculty from five academic departments within MIT. These faculty were responsible for over $ 13 M in microphotonics-related research funding over calendar year 1999. The MPC is coordinating further development of industrial support for the Microphotonics Center.

Microphotonics Center research will focus on basic device models, photonic bandgap materials, waveguides and microcavities, micro- and nanomagnets, quantum dots, semiconductor LEDs and lasers, advanced detector technologies including polymer-based signal amplification, self-assembled polymer devices, high-dielectric polymers, high-density optical integration, including development of filters for WDM applications, lithography, and nanometrics. Research collaboration is organized in three main teams: resonant structures and novel devices, integrated functionality, and new materials and processes.

The establishment of the Microphotonics Center last year was followed in January 2000 by a $90 million major industrial alliance with Nanovation Technologies, Inc. This six-year initiative will endow several chairs for microphotonics faculty members, support 27 new microphotonics research projects in 2000, as well as finance the construction of a new microphotonics processing laboratory, including cleanroom fabrication and characterization facilities.

RESEARCH

Highlights of the research performed by MPC faculty in 1999 are available on our web site at http://web.mit.edu/mpc/www/, and are reported in our Annual Reports, *Materials Research at MIT* (MPC) and *Bringing New Technology to Light* (Microphotonics Center). Of particular note are several results by Microphotonics Center faculty Edwin Thomas and Yoel Fink, whose "perfect mirror" technology has resulted in the development of a very low-loss "omniguide" optical fiber; and Lionel Kimerling's work with Ge-based photodetectors.

The MPC has successfully integrated a group of physics faculty into our MPC materials community. Professors Raymond Ashoori, George Benedek, A. Nihat Berker, Takashi Imai, Mehran Kardar, Patrick Lee, Leonid Levitov, Simon Mochrie, Alexander van Oudenaarden, and Xiao-Gang Wen have brought more than $ 1.8 million to our research volume as well as contributing to new MPC initiatives. The MPC mourns the passing of Professor Toyoichi Tanaka with the Physics Department and the entire MIT community.

NEW ACADEMIC/INDUSTRIAL PROJECTS

While the scientific foundation of the materials processing community at MIT has been established with federal research support, our future success is measured by our ability to leverage this knowledge base into industrially relevant applications. Our Industry Collegium, in collaboration with the MIT Industrial Liason Program, provides MPC faculty and senior research staff the necessary gateway to industry. The staff of the MPC works closely with both our Industry Collegium and Industrial Advisory Board members to understand their needs and match these with the expertise of our faculty. During the past year, MPC faculty and research staff have acquired nearly $ 2.167 M in new industrial research support from a total of 12 individual companies and federally funded industrial collaborations.

In addition, Professor Michael Cima has established new research partnerships to further develop Three-Dimensional Printing (3DP™) technology with several sponsors. He is working with NASA to explore "Forces During Manufacture and Assembly of Microscale Discrete Electronic Components" and has established an NIH-supported collaboration with Prof. Robert Langer to continue development of implantable electronics for drug delivery. These are now being used in preclinical experiments. In addition, the MPC has expanded Prof. Benedek's research effort by helping him obtain a significant NASA contract entitled "Kinetic Evolution of Stable and Metastable States in Protein Solutions."

The MPC provides an active industrial outreach function for the broad materials community at MIT, and leverages its Industry Collegium to expand the community's relationships with industry and to capitalize on the link between university research and industrial innovation. Our success is reflected by increase industrial research volume in the face of increasing academic and industrial competition for shrinking federal research support. Given that research

represents 75% of graduate education, the health of the academic community is highly dependent on its ability to serve the needs of industry effectively. At the same time, U.S. companies are increasingly dependent on outsourcing to solve current R&D problems and are seeking future growth opportunities through longer-term exploration of new products, processes, and directions. The MPC's ongoing challenge is to reach directly into industrial operating units, helping academic ideas become commercial innovations. We are structured to focus on establishing specific research program areas based on our strong external industrial partnerships. This approach requires continued expansion of our direct interaction with MIT labs and centers, including RLE, MTL, CMSE, TELAC, as well as with multiple academic departments.

Our overall research objective is to continue to expand our industrial research sponsorships in fiscal year 2001. In particular, we are expanding our efforts in the major research area of biomaterials. We will launch a relationship with the Pall Corporation during 2000 and have opened discussions with a major pharmaceutical company. The biomaterials theme of the upcoming Materials Day, mentioned above, will increase awareness of this important area within the MIT materials community.

ACADEMIC INITIATIVES

This year, the MPC continued supporting its new seminar series, Materials Unlimited. This seminar celebrates the diversity of the MIT materials community and spotlights the achievements of our graduate students. Recent speakers included Vanessa Chan (DMSE), whose research on block copolymers led to the development of a self-assembled double-gyroid template for nanoporous or nanorelief ceramic structures useful as high-temperature filters or as dielectric materials, and Lemelson Prize winners M. Jalal Khan, Michael Lim, and Thomas Murhpy (EECS), who have developed an efficient fabrication technique for Bragg grating add/drop filters. These filters are crucial for wavelength-division multiplexed optical telecommunications.

The MPC continues its Summer Research Internship in collaboration with the Center for Materials Science and Engineering. This 18th class includes ten interns working under seven faculty members in several departments. The Summer Research Internship program provides the faculty with much-needed seed support for exploratory projects and continues to meet our goal of providing undergraduates with an array of multidisciplinary research experiences in the materials field.

Under the aegis of the Microphotonics Center, the MPC sponsors a new weekly microphotonics seminar series to increase and develop the MIT community's awareness and understanding of this important area. The series featured speakers from industry, other universities, and MIT departments during this reporting period. Abstracts of the talks may be found on our web site at http://web.mit.edu/mpc/www/Events/phot-seminar.html.

CONCLUSIONS

MPC is the leading, and by far the largest, university research center with a materials processing emphasis. Our Collegium represents one of the strongest industry research interface at MIT. The MPC is ideally positioned to take advantage of the national shift in emphasis to engineering practice and outsourced R&D. We are structured internally to identify major research program areas and externally with strong industrial partnerships. We are successful if we maintain a strong, dedicated Industry Collegium; motivate faculty and students to address pivotal issues in materials processing and manufacturing; further involve women and minority faculty and students; and continue to increase the research throughput of the MPC in the coming year.

More information about the Materials Processing Center and its affiliated Microphotonics Center can be found on the World Wide Web at http://web.mit.edu/mpc/www/.

Lionel C. Kimerling

MICROSYSTEMS TECHNOLOGY LABORATORIES

The Microsystems Technology Laboratories (MTL) conduct research and education with an intellectual core of Semiconductor Industry Process and Device Technology, and Integrated Circuits and Systems Design. MTL also leverages its infrastructure to foster new initiatives at the Institute and to support the general microfabrication needs of MIT.

The MTL carries out graduate and undergraduate research activities in circuits and systems that are built using microsystems technology for applications such as wireless sensing networks and intelligent vision systems. Additionally, researchers are investigating the fabrication and study of small (i.e., micrometer to nanometer) structures and their use for the implementation of interesting integrated devices from nanometer-scale electronic devices to optical switches to displays to biosensors to microturbine engines. The MTL facilities include laboratory space for electronics test and assembly, computation and communication, and microfabrication. The MTL microfabrication facilities include three clean rooms; the state-of-the-art class-10 Integrated Circuits Laboratory (ICL), the flexible process environment Technology Research Laboratory (TRL), and the Exploratory Materials Laboratory (EML). In AY2000, the MTL fabrication facilities were utilized by 320 students and staff. The fabrication and computation facilities of the MTL are maintained and operated by a full time technical staff, and used by research students and staff.

Beyond the research programs, the MTL support several educational initiatives that leverage the research infrastructure of the labs. Chief amongst these is the undergraduate microfabrication laboratory, a lecture/laboratory course in which 120 students/year are afforded the opportunity to microfabricate an electronic device in the state-of-the-art MTL facilities. Additionally, we offer a project laboratory for team-based design of microfabricated structures. The Technology Demonstration Laboratory, developed by Professor Sodini, is housed in MTL and provides EECS M.Eng. students the chance to work on thesis topics with a technology integration and demonstration focus. Lastly, via the I-Campus Initiative, Professor del Alamo is developing a series of web-based laboratory tools that permit testing of microfabricated structures.

MTL maintains a strong and vibrant interaction with industries that value not only the research output, but also the students that are educated in state-of-the-art microsystems technology. The MTL facilities are supported in part by industry through the MIT Microsystems Industrial Group (MIG), whose current members include: Advanced Micro Devices (AMD), Analog Devices, Applied Materials, Compaq, IBM, Intel Corporation, Lucent Technologies, Motorola, Inc. Novellus Systems, Texas Instruments, and Taiwan Semiconductor Manufacturing Corporation (TSMC), as well as members of the Microsystems Affiliates Program whose members are Kokusai/BTI Corporation and Sony Corporation. Two industry-funded centers are also housed in the MTL; the Circuits and Systems Center, and the Intelligent Transportation Research Center.

HIGHLIGHTS

The clean-room space is being renovated for upgrade to 6" diameter silicon wafers. To date, more than $10 million of fabrication equipment (largely donated) has been installed in the building.

A new laboratory, the Exploratory Materials Laboratory (EML), was created in MTL this year. The lab was established to provide a thin film microfabrication facility for the users that were displaced by the closing of the former Microlab in CMSE. The integration of this laboratory into MTL compliments the existing laboratories and provides the users of MTL facilities with process capability that spans state-of-the-art silicon processes all the way to highly flexible novel materials microfabrication.

Profesor Jesus del Alamo was awarded a research grant under the I-Campus initiative to expand the web-based laboratory tools for education that he has developed.

Professor Judy Hoyt joined the faculty of EECS and MTL as an Associate Professor. Professor Hoyt's research in silicon-based materials and devices provides MTL with a critical research thrust in our core research area. She will establish an advanced film growth capability that will enable research in a class of devices that we previously had not explored.

FUTURE PLANS

We plan to complete the conversion and upgrade of our microfabrication facilities to a 6" diameter wafers compatible facility. This conversion will position MTL for continued contributions in research and education, and will solidify MTL as one of the premier university microfabrication facilities.

We will continue space renovations and relocations intended to optimize the utilization of our space. The MTL research and education initiatives have expanded by approximately 10 fold in the past 15 years without a significant growth in the space allocation to the laboratory. This has created intense pressure on the researchers in the laboratory and has forced us to continuously work to optimize the use of space in the laboratory. It is clear the primary limitation on growth of the laboratory into logical new research areas is paced by the availability of space to accommodate this growth.

MTL is in the midst of a strategic planning process that will conlcude this year. Since it's creation approximately 15 years ago, we have grown significantly in both numbers and research breadth such that MTL is now widely recognized as an international leader in microsystems. This growth has created a number of challenges and opportunities. The strategic planning process will enable us to address the challenges and select opportunities based upon our core strengths.

More information about the Microsystems Technology Laboratories can be found on the World Wide Web at http://www-mtl.mit.edu/.

Martin A. Schmidt

PROGRAM IN POLYMER SCIENCE AND TECHNOLOGY

The Program in Polymer Science and Technology (PPST), is an interdepartmental graduate education program. The program provides an opportunity for students at MIT to pursue an intensive polymer-centered education that ranges from molecular to continuum concepts in both engineering and science. The program, consisting of a core curriculum and a written and oral qualifying procedure, is administered by faculty from many diverse disciplines located in the departments of Materials Science and Engineering, Chemical Engineering, Mechanical Engineering and Chemistry. Although essentially an academic program, PPST also functions as a fostering community supporting polymer related activities at MIT. In this capacity, the program functions as an intellectual facilitator, bringing together polymer-interested scholars from within the MIT community and from outside academic and industrial institutions. The program also provides an opportunity to coordinate and enhance the material presented in the many different polymer subjects offered throughout the institute.

This past April, BP-Amoco Corporation supported the third PPST/BP-Amoco poster competition. More than 80 people attended this event including students, post-docs and faculty from many different departments at MIT. Posters were defended by 31 students/post-docs from four different MIT departments and $2200 in prize money was awarded at the end of the poster session. The winners this year were; "Best in Show" graduate student and post-doc, Catherine Santini (CE) and Dr. Bo Chen (DMSE); "Technical Creativity," Jung-Sheng Wu (CE) and "Contribution to Scientific Knowledge," Ariya Athakul (DMSE). Honorable mentions were also given to the following four students; Mitch Anthamatten (CE), Jonathan Hester (DMSE), Jinsang Kim (DMSE) and Jonas Mendelsohn (DMSE). The PPST seminar was judged by four BP-Amoco researchers. BP-Amoco Corporation also generously agreed to continue their support of the MIT UROP program. Rachel Sharp, a student working under the supervision of Professor Ned Thomas (DMSE), will be supported during the summer of 2000.

The PPST weekly seminar continues to attract an average of 50–80 students/faculty per seminar. This past year, stimulating lectures were presented by leading polymer faculty from a number of US and European universities as well as from within MIT. PPST seminars were also given by three MIT graduate students. Professor Paula Hammond (CE) has continued her important role of organizing the PPST seminar.

Eight new PPST students were admitted into the program from the departments of Chemical Engineering (2) and Materials Science and Engineering (6).

We have continued the implementation of our new core curriculum. In order to alleviate the problems associated with having too many subjects offered during the second semester and certain core subjects offered on an every other year basis, the faculty recently approved a modified program in which students are able to defer the taking of specific subjects until after the first year.

More information about the Program in Polymer Science and Technology can be found on the World Wide Web at http://web.mit.edu/ppst/.

Michael Rubner

SINGAPORE-MIT ALLIANCE

The Singapore-MIT Alliance (SMA) is a global partnership in graduate education among MIT, The National University of Singapore (NUS), and Nanyang Technological University (NTU). It aims to set a new standard for international collaboration in graduate research and education, to invigorate engineering education in Singapore, and to strengthen MIT through extending its global impact, enhancing its curriculum, and improving its infrastructure.

PARTNERSHIP

SMA was initiated on January 1, 1999, with students in the first two of the five planned "Programmes" started on July 1, 1999. These first two Programmes are "Advanced Materials" (AM) and "High Performance Computation for Engineered Systems" (HPCES). The third programme on "Innovation in Manufacturing Systems and Technology" is scheduled to begin in July, 2000, and Programmes in "Chemical Engineering" and "Computer Science and Engineering" are scheduled to begin in July 2001.

The academic calendar, course content, grading method and degree requirements for the three degrees offered in each Programme follow to large extent MIT practice and standards. The university hosting the program (NUS or NTU) awards degrees to successful graduates. Students also receive a SMA certificate confirming the completion of the program of study.

Each Programme will have a minimum of 6 faculty members from MIT, devoting up to half time to SMA, and an equivalent number from either NUS or NTU. Those devoting half time to SMA are designated "SMA Faculty Fellows." Targeted number of students enrolled in each Programme is 54. Of these, approximately 30 will be professional masters students enrolled in a one-year (12-month) course of study. The remainder will be research masters and doctorates.

Subjects are taught largely by distance education (DE). In addition to the distance education aspect of the Alliance, MIT Faculty Fellows will spend several weeks a year in Singapore in face-to-face lecturing and research collaboration. All SMA students will spend at least two weeks at MIT during their matriculation; doctoral students will spend a full semester at MIT. An annual symposium in Singapore will be held to evaluate progress and enable students and faculty to interact with industry.

Research comprises an important aspect of the research master and doctorate. Theses of all SMA research students are jointly supervised by an MIT and a Singaporean faculty member.

MANAGEMENT STRUCTURE

SMA is governed at the top by a "Governing Board" comprising academic, government and industrial leaders in Singapore and members of the faculty and administration at MIT. This Board is roughly comparable to a board of directors. At the next level down, a "Joint Academic Committee" meets quarterly (usually via video-conferencing). This committee comprises administration and faculty both from Singapore and MIT; its function is similar to that of a School Council. The individual academic "Programmes" are directed by "Faculty Chairs" (one from MIT and one from Singapore), responsibilities of these Chairs are similar to those of a Department Head.

Administratively, SMA is managed by two Co-Directors and two Deputy Directors, one each from Singapore and one from MIT. The MIT Co-Director is Merton C. Flemings, who also serves as Director of the MIT Center for the Singapore-MIT Alliance. Anthony T. Patera is Deputy Director and Anddie Chan is Assistant Director.

ENTERING CLASS

A total of 590 applications were received for the three programmes operating in academic year 2000–2001.149 offers were made and 106 applicants accepted the offers. Of these 37% were from China, 32% were from Singapore, 16% from India and the remainder from other South East Asian countries. GRE scores were waived for students from top schools in Singapore. However, those student scores obtained compare favorably with the scores of students being admitted to graduate school in MIT's Departments of Mechanical Engineering and Materials Science and Engineering. Besides the draw of the MIT name, one factor that has aided in recruitment of top students is the fact that all students are offered full fellowship support (including travel costs) for their entire matriculation. Both GRE and TOEFL scores for the Class 2000 are slightly higher than last year's class.

ADVANCED MATERIALS

The SMA degrees in Advanced Materials offer broad foundations in advanced materials. They cover the fundamentals of electrical, optical, magnetic and mechanical properties of materials, and the fundamentals of processing of materials for high technology applications, with an emphasis on applications in microelectronics.

The S.M. degree (a professional master's degree) in advanced materials constitutes a 12-month program, including three subjects in the necessary fundamentals, and three electives with a focus on microelectronics. The degree also offers students an opportunity to carry out a semester-long research or industry project. The M.Eng. degree (a research master's degree) includes a similar, but more rigorous, core curriculum and a master's thesis jointly supervised by SMA fellows from Singapore and MIT. The Ph.D. degree includes an expanded choice of elective subjects and a minor subject selection outside of the materials area.

The programme has enrolled 18 S.M. students and 15 M.Eng. and Ph.D. students. The M.Eng. and Ph.D. students had spent the fall 1999 term at MIT, taking two courses with the MIT students. They took the same exams as the regular MIT students and their performance was statistically indistinguishable from that of their MIT peers.

A number if innovations in distance education are being developed through the SMA programme. In fall 1999, a new tool developed at MIT was successfully used to remotely operate device characterization equipment at MIT from NUS. Additional distance education innovation is planned for the summer of 2000.

The research collaborations growing from co-supervision of M.Eng. and Ph.D. student research has already led to the submission of joint publications and presentations at an international conference. Joint research activities among the Alliance universities and Singaporean research institutes have also been initiated in a number of areas, especially in the area of metallization and materials reliability in microelectronics.

The MIT Chair of the Advanced Materials Programme is Carl V. Thompson. Faculty members involved include Subra Suresh (Programme Advisor) who stepped down as Programme Chair in February 2000 after his appointment as Head of DMSE at MIT, Lallit Anand, Dimitri A. Antoniadis, Criag Carter, Gerbrand Ceder, Joel P. Clark, and Eugene A. Fitzgerald as Faculty Fellows.

HIGH PERFORMANCE COMPUTATION FOR ENGINEERED SYSTEMS

The SMA programme in High Performance Computation for Engineered Systems is focused on high performance computation—simulation and optimization—of engineered systems. High performance computation is a crucial component in the modeling, simulation, design, optimization, control and visualization of engineered systems in a wide range of technology and service industries. Students learn to apply and develop advanced numerical techniques for simulation and optimization relevant to a diverse set of applications from aerospace, electrical, industrial, mechanical, and other engineering fields, as well as logistics, management, and finance.

The S.M. (a professional master's degree), M.Eng., and Ph.D. degree programs all include a core curriculum; the M.Eng. degree requires a master's thesis; the Ph.D. degree also requires several additional advanced courses and a doctoral thesis. The S.M. degree focuses on the critical and effective application, modification, and integration of existing simulation and optimization software; the M.Eng. and Ph.D. degrees emphasize the formulation, analysis, and implementation of new computational methods for the simulation and optimization of engineered systems.

From fall 1999 to Spring 2000, four subjects were taught to both SMA (via video-conferencing and taped lectures) and MIT students; three in the fall of 1999 and one in the spring of 2000. The SMA students performed very well when compared with the MIT cohort.

The HPCES programme has chosen the broad area of "Effective Computation for Design and Operation of Engineered Systems" as its research theme. There are already quite a few publications from the Singapore and MIT Fellows in conference proceedings and archival journals which cite SMA support.

The MIT Chair of the High Performance Computation for Engineered Systems Programme is Anthony T. Patera. Faculty members involved include Thomas Magnanti (Programme Advisor), Dimitris J. Bertsimas, Robert M. Freund, Thomas L. Magnanti, and Jaime Peraire, Jacob K. White as Faculty Fellows, and Georgia Perakis, Andreas Schulz and Nitin Patel as Associates.

INNOVATION IN MANUFACTURING SYSTEMS AND TECHNOLOGY

Degree programs in Innovation in Manufacturing Systems and Technology (IMST) include the S.M., the M.Eng., and the Ph.D. IMST offers highly competitive courses of study that explore the many facets of manufacturing technology. Challenging coursework integrates the process, product, system and business aspects of this vibrant industry, while focusing on the core of manufacturing systems. Advanced coursework will expose students to innovative theories and methodology, as well as a rigorous investigation of financial, strategic and global aspects of technology innovation and new business generation.

The S.M., M.Eng., and Ph.D. degree programs all include a core curriculum; the S.M. degree includes a theme project; the M.Eng. degree includes a Master's level research thesis; the Ph.D. degree includes additional subjects on advanced topics in each of the fundamental areas.

The S.M. degree program is aimed at practitioners who will use this knowledge to become leaders in existing, as well as emerging, manufacturing companies. The M.Eng. and Ph.D. degree programs will prepare students for careers in industrial research and development centers, research institutes or academic departments interested in fundamental research in manufacturing.

The MIT Chair of the Innovation in Manufacturing Systems and Technology Programme is David E. Hardt. Faculty members involved include Lallit Anand, Jung-Hoon Chun, Steven D. Eppinger, Lawrence M. Wein and Kamal Youcef-Toumi as Faculty Fellows. Stanley B. Gershwin as Associate.

PRE-IMMERSION AND IMMERSION PROGRAMMES

All SMA students spend two and a half weeks at MIT as part of the "Pre-Immersion" and "Immersion" Programmes. The Pre-Immersion Programme comprises discussions with entrepreneurs in the fields. The Immersion Programme comprises of lectures and lab sessions taught by MIT faculty.

DISTANCE LEARNING

MIT's Center for Advanced Educational Services, under the direction of Richard C. Larson, has assumed responsibility for the technology and operation of the distance learning aspects of SMA. SMA staff work closely with CAES staff in selecting modes of operation and necessary equipment through an SMA Distance Education Working Group jointly chaired by Anddie Chan (SMA Assistant Director) and Mike Barker (Acting SMA Project Manager). An important aspect of work ahead is to help bring on line at least one new distance learning classroom in Fall 2000 and two additional classrooms in mid 2001. In addition to CAES, SMA staff also work closely with MIT's Educational Media Creation Center and Information Services to implement high bandwidth connection for the distance education classes. Vijay Kumar, Assistant Provost, and Richard Larson, Director of CAES are jointly responsible for the SMA's web-based platform development.

BENEFITS AND GOALS

Singapore's goals for SMA include invigorating its engineering education, enhancing creativity and entrepreneurship in its educational system, and attracting talented young people to Singapore.

On the MIT side, an important benefit is that this highly focused, well funded alliance gives us the opportunity to develop our own modes of operation, based on communications technology, to broaden our role as a global university, to define our own style of contact-intensive distance education, and to learn how to bring this global interaction to Cambridge to enhance undergraduate and graduate education of our own students.

We anticipate strengthened departmental curricula as a result of SMA funded new and existing subject development. We also anticipate enhanced inter-departmental and inter-school collaborations as a result of both SMA curriculum development and SMA funded research projects. As examples, the HPCES Programme will engender a number of new and well-supported cross-department and cross-school MIT courses, as well as research collaborations and a seminar series, that will benefit MIT (residential) students. A new Master of Engineering in the Department of Materials Science and Engineering, a part of the strategic plan of the Department, has been greatly aided in its development by the funding and course development of SMA. Similar synergies are planned for the IMST programme.

FURTHER INFORMATION

Additional Alliance details may be obtained by contacting Ms. Anddie Chan, Assistant Director, SMA, Tel.: (617) 253-4222 or e-mail: anddie@mit.edu. More information about this center can be found on the World Wide Web at http://web.mit.edu/sma/.

Merton C. Flemings

SYSTEM DESIGN AND MANAGEMENT PROGRAM

The mission of System Design and Management Program is to educate future technical leaders in architecting, engineering, and designing complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily at a distance.

The SDM Program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a Master of Science degree in Engineering and Management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education format for company-sponsored students, requiring one academic semester in-residence at MIT; and a 24-month, on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers. The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

Co-directors for the program include Paul Lagace (Engineering), Steve Graves (Management), and Bill Hanson (Industry) and John Williams (Engineering) until his sabbatical in January 2000. In June, Thomas Kochan from the Sloan School also continued in the combined enterprise as a co-director filling in for Steve Graves' during his sabbatical.

In June 2000, SDM graduated its second full class. Forty-five of the fifty-eight graduates attended the commencement ceremony to receive their degrees - a tribute to the cohesiveness of this distance education group. The graduating class includes seventeen employees from Ford, twelve from UTC and three from Xerox, and two from Kodak, as well as employees from Fuji Xerox, ITT, PictureTel, Intel, USAF, ComputerVision, Silicon Graphics, Sun MicroSystems, Comicrom SA, and Honeywell.

In January 2000, SDM admitted its fourth class, enrolling fifty students. Forty-three students admitted in 1999 continued in the program, with three 13-month students from the January 1999 class graduating in Spring 2000. In all, twelve companies sponsored students in the incoming class, including four sustaining enterprise companies: United Technologies Corporation sponsored four students, Ford Motor Company sponsored thirteen, Xerox Corporation sponsored six, and Eastman Kodak sponsored two students. Other sponsoring companies include: NASA which sponsored seven students for the first time, Polaroid, Delphi Packard, U.S. Navy, IBM, Intraware, Integrity Solutions and Mide Technology.

TABLE 1.

SDM STUDENT STATISTICS	1997	1998	1999	2000
Admitted	35	58	47	50
On-Campus	8	16	6	14
Self-Supported	3	1	2	5
Research Assistant	3	12	2	4
Distance Education	27	42	41	36
Company Sponsored	29	45	43	41

Specific program accomplishments included:

Students

- Admitting the fourth class of fifty SDM students.
- Graduating fifty-four students from the 1998 distance education program for new careers in systems as well as graduating three thirteen-month students from 1999 class. All but one of the 1998 students have now graduated and many students have successfully parlayed their SDM education into new positions in their companies—these promotions occurred either while they were in the SDM program or after graduation. The Program Office has begun the process of exit interviews with this group of newly graduated students.

- Continuing support of an SDM student council to work on student concerns and issues that are unique to the SDM program. Student council initiatives this year included planning for the International Business Trip and establishing a student committee to more fully utilize the time spent on Business Trips.

Curriculum Development

- Continuing the development of the three SDM core subjects in system architecture, system engineering, and system and project management. Ed Crawley, the faculty for System Architecture, was provided with additional TA support to work on further improvements in the course. Additionally, a curriculum committee has been re-instituted for SDM to begin to look at the curriculum. This effort will be the first review of the curriculum since the program's inception in 1996. At the June LFM-SDM Workshop, committees were formed to look at five initiatives meant to strengthen the LFM and SDM programs. SDM-specific initiatives include a team looking at the SDM value proposition and curriculum and a team studying the effectiveness of distance education.

Collaboration and Outreach

- Sharing of placement resources. Although sponsored SDM graduates will return to their companies, unsponsored graduates will typically seek new careers in systems engineering and product design. LFM-SDM offered placement services to all non-sponsored SDM students.
- Leading an effort to replicate the SDM product development track at other universities to help them develop and introduce an SDM-like program. Together with Ford, IBM, ITT, RIT, UDM, the U.S. Navy, and Xerox, SDM and CIPD have formed a consortium called PD21: The Education Consortium for Product Development Leadership in the 21st Century, to disseminate the product development curriculum to other universities. SDM has taken a lead role in the consortium1999 saw the first cohort of students enter similar programs to SDM at Rochester Institute of Technology and University of Detroit Mercy. Both schools successfully recruited a second cohort that began in January 2000. A new consortium member, the Naval Postgraduate School, will matriculate its first cohort in September 2000.

Distance Education Delivery

- Delivering the full range of SDM course offerings to both on-campus and remote students, including three core systems courses, six fundamental courses, and five elective courses satisfying SDM's design, engineering, and management elective requirements. The faculty have substantially adapted other courses for the distance education medium of multipoint videoconferencing to as many as 15 simultaneous company sites.
- Continuing to provide web support for faculty and students as well. The COMMAND System, developed by John Williams and a lab of research assistants, has been used successfully since the inception of the program. SDM is looking at further ways to use the web to support its faculty and students.
- Experimenting with new distance formats. When SDM students could not get into Rebecca Henderson's Technology Strategy course because of over enrollment, SDM program administrators created a course format in which SDM distance students receive the core of Henderson's teaching while not necessarily having direct access to her time throughout the semester. The alternative, which relies heavily on traditional distance education technology, includes using taped classes from Henderson's previous semester on-campus class and live, videoconferenced recitations with high-level graduate students serving as teaching assistants. The format also featured a two-day workshop on campus during which Henderson devoted herself entirely to SDM students who travelled to MIT

LFM/SDM PARTNERSHIP

As reported last year, after much discussion and consultation with the Deans of Engineering and the Sloan School of Management, on July 1, 1999, Leaders for Manufacturing and System Design and Management Program officially consolidated their administrative staff. Much energy has been devoted during the last year not only to achieve the economy of scale planned for by the consolidation, but also to understand how these two related programs can work more effectively for the LFM-SDM partnership as a whole.

One of the first actions taken by the new LFM-SDM partnership was to advertise for the position of Director of Fellows (SDM). Created to mirror the position held by Don Rosenfield in LFM, the Director of Fellows (SDM) reports to the LFM/SDM co-directors, has primary responsibility for the overall SDM program and involves both administrative and teaching responsibilities within the SDM program. Dennis Mahoney, a retired captain in the Navy (engineering duty) began serving in this position on August 1, 1999.

As a newer program within the Institute, SDM has already benefited considerably by its association with LFM. Processes already established by LFM have been adapted to SDM, including entrance and exit interviews and

greater emphasis in the admissions process in collecting data for determining profiles of successful SDM students. A new effort was begun to get placement and salary data of graduates in an effort to determine what the experience of SDM graduates were after the program in partner companies and in companies that hire non-sponsored SDM students. The Operating Committee and Governing Board for LFM assumed oversight of the SDM program, and began the process in FY2000 of bringing advocates for both programs onto these boards. Because there was little history of industry partnership for SDM, much work still needs to be done in this regard. Of the four SDM enterprise partners (Ford Motor Company, United Technologies Corporation, Eastman Kodak Company, and Xerox Corporation), only Xerox was not a partner with LFM, but has since been invited to join as a full partner of LFM-SDM.

Much time over the last year has been spent determining the future direction of this new entity within the Institute. Beginning with a two-day off-site with co-directors in June 1999, this effort led this year to the production of a White Paper entitled, "A Strategic Vision: Building on and Strengthening the LFM-SDM Programs." LFM-SDM have chosen the phrase "Leaders for the Total Enterprise" (LFTE) as the central concept around which to build the next generation LFM and SDM programs.

LFTE maintains and builds on the unique bases of LFM and SDM and thereby allows the interdisciplinary issues facing organizations to be effectively addressed in a broader context while still maintaining our originals focuses on issues in the more local domains. The new larger partnership of LFTE allows LFM-SDM to continue to address the two key discipline areas of engineering and manufacturing (product design, development and delivery) while broadening our domain and thereby learning about and developing the practices and principles that occur at the interface and integration of these disciplines.

There are four thrusts to developing LFTE:

- Developing principles and practices for the Total Enterprise, which includes as all the people and entities along an organization's value chain that are involved with the design, development, manufacture, and distribution of a product or family of products.
- Developing a strategy for knowledge management, including knowledge generation, development, and transfer.
- Lifelong education, including developing the educational supply chain,
- Distance education, including the use of new technologies to support lifelong education and educate the many and the few.

After discussion with all the partners and stakeholders, it was determined that while there was interest in how a combined LFM-SDM might develop in the future, stakeholders were focussed on how LFM-SDM might strengthen the two individual programs. Accordingly, LFM-SDM held a faculty retreat in June, attended by faculty, students, alums, partner companies and staff. This year's topic "Strengthening and Building on the LFM and SDM Programs" was driven by the need to continually adjust the programs to meet the changing needs of all our partners--students, alumni, faculty, and industry.

After a full day of brainstorming, the group determined five initiatives that it wanted the partnership to address within the next six months. These initiatives included:

- Revisiting the LFM mission/vision
- Clarifying the SDM value proposition/vision
- Re-instituting SDM's curriculum committee, composed of company, faculty, and
- Students, to articulate and define the program's fundamental intellectual underpinnings
- Distance education
- Defining and enhancing lifelong learning for both LFM and SDM

Global teams consisting of representatives from all stakeholder constituencies have been formed and are working on addressing these issues over the long term.

Current LFM-SDM Co-directors are: Stephen C. Graves, William C. Hanson, and Paul Lagace.

More information about SDM can be found on the World Wide Web at http://lfmsdm.mit.edu/.

William C. Hanson

TECHNOLOGY AND POLICY PROGRAM

The MIT Technology and Policy Program (TPP) provides an integrative education to scientists and engineers who wish to lead in the development and implementation of responsible strategies and policies for exploitation of technology for the benefit of their communities. TPP's guiding vision is the education of 'Leaders Who Are Engineers.'

The TPP graduate educational program in the School of Engineering acknowledges that the development of the skills necessary for effective implementation of technology tie into the emerging engineering systems educational thrusts and, consequently, TPP is part of the Engineering Systems Division of MIT. The Program focuses on providing a high impact, high quality education to its students. Its goal is to make TPP the most prestigious and sought after technology policy program in the world and to produce the technological decision makers of the future.

TPP sponsors both a Master of Science program and the Technology, Management and Policy (TMP) doctoral program. This year's class of Master of Science in Technology and Policy included 39 graduates, and 5 continued on as doctoral students. This year's "Best Thesis in Technology and Policy" was awarded to Mon Fen Hong. The TMP program has a current enrollment of twenty-five students, reflecting a steady-state admission rate of about five students per year. Four students received their Technology, Management and Policy Ph.D. in June 2000. This year a TPP Student won the $30,000 Lemelson Award. Amy Smith won the sixth annual Lemelson-MIT Program Student Prize for inventiveness. Smith, a S.M. candidate in the Technology and Policy program, earned the $30,000 prize for her dedication to applying mechanical engineering design skills to the invention of technological devices for use in developing countries. In addition to her phase change incubator, Smith has also invented devices including a grain mill adapted for rural areas of developing countries where women traditionally spend up to four hours a day grinding grain by hand.

February 1, 2000 marked the installation of Professor Daniel E. Hastings as Director of the Technology and Policy Program. A key objective of his first semester of program leadership has been the development of a strategic plan aimed at achieving three key objectives for the program: increasing TPP's intellectual footprint at MIT and the surrounding community; embedding TPP and TMP into the MIT Engineering Systems Division (ESD); and raising the external visibility of TPP. Other key events have been a reorganization of TPP administration and the formation of TPP faculty committees (drawn not only from ESD, but also the Sloan School and HASS) to create a broader institutional basis for the development of program policies.

Daniel Hastings

TECHNOLOGY, MANAGEMENT, AND POLICY PROGRAM

The Technology, Management, and Policy Program (TMP) is an interdisciplinary Ph.D. program directed at producing world-class researchers striving to improve methods used in defining and implementing policies for the intelligent use of technology. The program was established in 1992 and became a part of the Engineering Systems Division in 1998. The students within the program are motivated by their recognition of specific problems at the boundaries between technological development and social and industrial policy. The goals of the TMP program are to supply an academically rigorous environment within which these students, under the guidance of MIT faculty, work to extend the nature and purview of the tools needed to understand and address these issues.

The common vision of the program participants is that a dual competency in a technical area and in management and policy is the basis for the effective design of large-scale systems. The research efforts within the program are leading to the development of a new paradigm for the planning and design of engineering systems—a paradigm that blends technical expertise with competence in economics, management, and policy to achieve a better adaptation of technology to societal goals.

Students are not directly admitted to the program; rather, they are first admitted to the Master's program in Technology and Policy. Upon their arrival at MIT, these potential TMP students then prepare a case for admission to the TMP program, which requires that they construct an appropriate research question, assemble a cadre of MIT faculty committed to that effort, and develop a proposed curriculum that will assure that the student will be equipped to address this question in a manner consistent with the highest academic standards of the fields represented. This admission case is then reviewed by the TMP admissions committee, composed of faculty drawn from the MIT Schools of Engineering, Management, and Humanities, Arts, and Social Sciences.

Although the majority of the students in the program initially came to MIT solely for the S.M. in TPP, there has been an upsurge in applicants who have specifically targeted admission to TMP over the past three years. The program currently admits about five students each year, and students take approximately five years to complete their degrees. There currently are 25 students enrolled in the TMP program, and four TMP Ph.D.s were awarded this year. These graduates have joined their colleagues in careers in industry, academia, and the government.

With the installation of Professor Dan Hastings as the new director for TPP, and the inclusion of TPP into the ESD family of educational programs, a TMP faculty committee, with members drawn from ESD, the Sloan School and HASS, has begun to meet to work to more completely define the mission of the TMP program, particularly vis-a'-vis the emerging plans for an ESD Ph.D. program. Furthermore, several policy changes, particularly regarding the composition of TMP thesis committees and the representation of core TMP faculty upon those committees, have been instituted.

Daniel Hastings

DEAN, SCHOOL OF HUMANITIES AND SOCIAL SCIENCE

Effective July 1, 2000, the name of the school will change to become the School of Humanities, Arts, and Social Sciences (SHASS). The new inclusion of "Arts" in the name is intended to acknowledge the unique and fundamental ways in which the arts curricula contribute to the overall educational mission of the school and the Institute. It is particularly fitting that the school's name change occurred during the landmark year of 2000—the year the school celebrates its 50th Anniversary as part of MIT. To recognize this milestone occasion, a series of events have been planned that will form an exciting tribute to the School's fifty-year history at MIT on October 6th and 7th.

In the meantime, the School continues to build and refine its undergraduate and graduate programs and to focus its efforts on affirmative action, fund-raising, and faculty recruitment in departments and sections which are experiencing retirements and resignations. The faculty received a number of honors and awards, and some important administrative changes within the School have occurred.

UNDERGRADUATE EDUCATION

Approximately twenty-five pilot HASS (Humanities, Arts, and Social Sciences) Communication Intensive (CI) subjects—including both HASS-Distribution and HASS-Elective courses—were offered in 1999–2000. In this second year of the pilot phase, roundtable discussions were again held for the instructors of these courses. Although experiences varied depending on the type of CI course—single section vs. lecture with recitation sections, for example—the general reaction was positive. Instructors believe that HASS CI courses are fulfilling their goal of improving students' written and oral communication skills. Those instructors who had taken advantage of the option of hiring a writing tutor for assistance reported satisfaction with that arrangement; they felt that besides easing the burden somewhat for them, their students had benefitted.

The HASS Minors continue to be popular with undergraduates. Two new HASS Minors were added effective Fall 1999 (Ancient and Medieval Studies and Public Policy) bringing the total to twenty-seven.

The HASS Overview Committee (HOC), chaired by Professor Jean Jackson, had another busy year. In addition to its regular task of reviewing HASS-D proposals, the HOC dealt with a number of other issues involving HASS, including HASS CI courses. In the upcoming academic year, the HOC will focus on establishing the criteria and monitoring procedure for HASS CI's effective Fall 2001, when the new Communication Requirement goes into effect.

NEW INITIATIVES

The Program in Writing and Humanistic Studies has been exploring the development of a new masters program in Science Writing, with the educational mission of improving the public understanding of science. Such a program seems particularly relevant to MIT, where excellence in scientific research is a hallmark. This new program would build upon existing curricula and faculty in Writing and Humanistic Studies and in Comparative Media Studies, and would also form a natural complement to the MIT Knight Science Journalism Fellowships Program, administered in the Program in Science, Technology and Society. We believe there is a strong pool of potential students as well as fundraising opportunity in this area. The new program will take roughly three years to fully develop before admitting its first students.

MIT's International Science and Technology Initiatives (MISTI) is developing a program with France, to explore new research and educational opportunities in collaboration with French industry and government. The initial program includes funding to support visiting professorships in France which would be open to any fields among those represented at MIT, as well as the support of a program administrator. There is the possibility of this program also supporting a new endowed professorship at MIT devoted to the study of French civilization.

AFFIRMATIVE ACTION

The affirmative action record of SHSS continues to appear strong relative to the rest of the Institute, but this is mainly because the representation of women within the fields of humanities and social science is relatively large. The School's record relative to the pool, however, is about average. Within the School for 1999–2000 there were 49 women faculty, which represents 32 percent of the total faculty. Of these, 30 are tenured (30 percent of the tenured faculty). Throughout the last decade, the total number of women faculty has steadily increased (30 in 1990–91), and the School has been making every effort to continue this trend. Unfortunately, while we were successful in recruiting an Asian woman at the assistant professor level in Political Science (effective AY2001), we will also be losing three women junior faculty members at the end of this year, yielding a net loss of two women to the faculty. The number of women faculty in 2000–2001, therefore, will be 47. Of the two SHSS faculty promoted internally and approved for tenure in AY2000 (to be effective July 1, 2000), one was a woman.

The School has not been quite as successful in its efforts to recruit minority faculty, although we successfully recruited an Asian woman to join the Department of Political as assistant professor effective July 1, 2000. However, we unhappily report the loss of three minority junior faculty (two African-Americans—one man, one woman—and one Native American woman) at the end of this academic year, yielding a net loss of two minorities to the faculty. With the help of the Provost's Initiative, we hope to step up our efforts to recruit qualified minority candidates. The total number of minority faculty in the School, including Asian Americans, will drop from 22 to 20 next academic year, representing 13% of the total faculty.

We remain committed to increasing the minority representation of the administrative staff. Currently, we have only three minorities (one Hispanic and two Asian-Americans) of a total of 31 (approximately 10%). We hope to further diversify our administrative staff by working closely with the Departments and Programs in the School and with the Personnel Office.

HONORS AND AWARDS

The faculty within the School of Humanities and Social Science garnered an array of honors and awards this year. The most notable among them were the following: Professor of History John Dower's book, *Embracing Defeat: Japan in the Wake of World War II*, received a number of prestigious literary awards, including the Pulitzer Prize in General Non-fiction, National Book Award for Non-fiction, Los Angeles Times Book Prize in History, and the Bancroft Prize for "distinguished works in American history and diplomacy." Associate Professsor of Literature James Buzard was awarded the James Levitan Prize in the Humanities. McMillan-Stewart Professor in the Study of Women in the Developing World Susan Slyomovics won the Chicago Folklore Prize and the Albert Hourani Book Award for her book *Object of Memory*. Professor of Economics Franklin M. Fisher was named the first holder of the Jane Berkowitz Carlton and Dennis William Carlton Chair in Microeconomics. Institute Professor of Linguistics Noam Chomsky was awarded honorary degrees from Harvard University, University of Toronto, University of Western Ontario, and Scuola Normale, PISA. The Department of Economics' Professor Ricardo Caballero was awarded the Ford International Professorship of Economics; Associate Professor Jaume Ventura was appointed to the Pentti Kouri Career Development Chair; Professor Abhijit Banerjee received a Guggenheim Fellowship; Institute Professor Peter Diamond received a Fulbright Fellowship; and Elizabeth and James Killian Professor of Economics and Management Paul L. Joskow was appointed to the Bogen Visiting Chair at Hebrew University. Professor of History and Philosophy of Science Evelyn Fox Keller received a Guggenheim Fellowship and honorary degrees from Allegheny College and The New School University. Associate Professor of Theater Arts Brenda Cotto-Escalera received a Woodrow Wilson National Foundation Award. Castle Krob Career Development Associate Professor Susan Athey received a prestigious National Science Foundation Career Award and a Hoover Institution National Fellowship. Professor of the Sociology of Science Sherry Turkle was awarded the Abby Rockefeller Mauze Professorship. The Department of Linguistics and Philosophy's Associate Professor of Philosophy Ralph Wedgwood received the Jean Hampton Prize from the American Philosophical Association; and Assistant Professor Norvin Richards was named the Mitsui Career Development Professor of Linguistics. Assistant Professor of Literature Christina Klein was awarded a Fellowship at the Charles Warren Center for American Studies at Harvard University. Assistant Professor of Economics Sendhil Mullainathan was named the first holder of the Mark Hyman Jr. Career Development Chair and was appointed Zvi Griliches National Fellow by the National Bureau of Economic Research. Associate Professor of Political Science Melissa Nobles received a Research Fellowship from Boston University's Institute on Race and Social Division. The Department of Economics' Assistant Professor David Autor was elected a Faculty Research Fellow for the National Bureau of Economic Research and a Faculty Affiliate of the Joint Center for Poverty Research, University of Chicago/Northwestern University; and Professor Nancy Rose was elected to the American Economic Association Executive Committee. Associate Professor of Writing Susanne Klingenstein received the Certificate of Merit from the Counsel General of Germany for distinguished literary criticism. Assistant Professor of Chinese Studies Emma Teng Chung received the J. Paul Getty Postdoctoral Fellowship Award.

FUNDRAISING

Fiscal year 2000 has continued the pace of the previous fiscal year and several major gift commitments were made after extended efforts on the part of senior development and school staff and Dean Philip Khoury.

New gifts and pledges in fiscal year 2000 total $10,890,230. Some of the giving highlights include the T.T. and Wei Fong Chao Professorship in Asian Civilizations, the Leon (1926) and Anne Goldberg Professorship, the Jane Berkowitz Carlton and Dennis William Carlton Chair in Microeconomics, and a significant funding increment for the Knight Science Journalism Program.

The central development office (Office of Individual Giving) at MIT was reconfigured to form the Office of Campaign Giving (OCG) and is now almost fully staffed. The Assistant Dean for Development for the School, Josey Twombly, works closely with OCG co-directors David Woodruff and Chris Rinaldi and the major gifts staff to

identify, cultivate, solicit, and steward prospects and donors. Judith Sager joined the development staff as Director of Gift Planning, and she is expanding that operation and actively collaborating with central and school development staff on planned giving prospects.

The development priorities for the campaign and beyond are to:

- identify new prospects for SHASS;
- engage prospects in MIT and the school and its campaign goals and, at the appropriate time, to solicit support for the school; and
- develop and implement cultivation and stewardship activities for prospects and donors.

The fundraising priorities for SHASS include increased funding for graduate fellowships, professorships and support for young faculty, and research and technology funding, as well as targeted funding for the Shakespeare Archive, Comparative Media Studies, the Washington Internship Program, and MISTI.

FACULTY PROMOTIONS, ADMINISTRATIVE CHANGES, RETIREMENTS

This year has seen eight resignations and six new faculty appointments within the School. Among the faculty resignations were two associate professors without tenure (one in Economics and one in Foreign Languages and Literatures), a full professor in Economics, and five assistant professors in Economics, History, Music and Theater Arts, Political Science, and the Program in Writing and Humanistic Studies. A total of three faculty members in the School were promoted to tenure this year, effective July 1, 2000: Dora Costa of the Department of Economics; Hugh Gusterson of the Programs in Anthropology and Science, Technology and Society; and Edward Gibson, jointly appointed in the Department of Brain and Cognitive Sciences and the Department of Linguistics and Philosophy.

The School was successful in recruiting six new members to the faculty during 1999–2000. All but one (hired as Professor of Comparative Media Studies and jointly appointed in Literature and Foreign Languages and Literatures) were hired as assistant professor in the following departments: two in Economics, one in Political Science, one in History, and one in the Program in Science, Technology and Society.

Academic Year 1999–2000 saw two former department heads return to service. Cutten Professor of the History of Technology Merritt Roe Smith replaced Professor Michael Fischer as Director of the Program in Science, Technology and Society. Professor of French Studies Isabelle de Courtivron replaced Professor of Linguistics and Second Language Acquisition Suzanne Flynn as Section Head of Foreign Languages and Literatures. We will miss the insights and administrative wisdom of Professors Fischer and Flynn, and wish them well as they return to a professional life focused principally on scholarship and teaching. Class of 1949 Professor of Music Ellen Harris will become the next Head of the Music and Theater Arts Section.

More information about the School of Humanities and Social Science can be found on the World Wide Web at http://web.mit.edu/shass/.

Philip S. Khoury

HUMANITIES, ARTS, AND SOCIAL SCIENCES OFFICE

There have been several innovations in the HASS Office during the past year which have made it possible to disseminate and store data more efficiently, as well as to improve our ability to accomplish other tasks. Freshmen will be able to enter the HASS-D Lottery on the Web this summer for the first time, with the paper forms as a backup. A new Filemaker database for Course 21 majors makes it possible to keep track of these majors over the years. New websites have been created for such things as HASS CI (Communication Intensive) course criteria and answers to questions frequently asked by freshmen concerning the HASS-D Lottery. Most of the appropriate subjects taken by MIT undergraduates at Harvard under the cross-registration program are now automatically coded as HASS, saving students the trouble of petitioning each one and staff the time spent approving and processing those petitions. The HASS Office has established a database containing these subjects which will be updated as additional subjects are coded. In addition, this office maintains the Web list of HASS CI courses and reports to the Writing Requirement Office those students who have completed Phase I of the Writing Requirement based on their performance in a HASS CI class.

The HASS Overview Committee, on which the Coordinator, Dr. Bette Davis, serves as *ex officio*, had another busy year. In addition to reviewing HASS-D proposals in the fall and taking care of other routine business, the Committee spent some time on the issue of HASS Communication Intensive (CI) courses. As noted above, the HASS Office has major administrative responsibility for the HASS CI system in the current pilot phase.

ENROLLMENT STATISTICS BY FIELD AND SUBJECT

Total enrollments in all HASS subjects were stable—10,132, compared to10,091 in AY1999. The number of HASS subjects offered was also stable—478, compared to 476 in 1998–99—while the number of autonomous sections increased from 582 to 609. The number of HASS-D subjects taught was almost exactly the same, 118, compared to 117 last year. The largest overall enrollments were in the same fields as last year, in the same order: 1745 in Economics (down slightly from 1795 last year) and 1509 in Foreign Languages and Literatures (up from 1324 last year). Writing (990) was again third, followed by Literature (920), Music (721, six-unit music performance subjects are not included in these statistics), and History (663). (*Archaeology had the largest increase over last year in terms of percentage (from 122 to 147, or 20%), followed by History of Art and Architecture (from 127 to 150, or 18%) and Foreign Languages and Literatures (14%, from 1324 to 1509).

In 1999–2000, students submitted 2229 HASS Concentration proposals and 1267 completion forms, compared to 2293 proposals and 1274 completion forms last year. Once again, Economics and Foreign Languages led in the number of completed HASS Concentrations: in 1999-2000, 367 (compared to 357 last year) students completed concentrations in Economics, and 236 completed concentrations in Foreign Languages and Literatures, compared to 220 last year. (For a breakdown by languages, see Table II.) The next two most popular HASS Concentration fields are Music, with 109 completed concentrations, and Psychology, with 70, followed by History (63), Writing (56), and Literature (54).

1999–2000 showed a decrease in the total number of HASS Minor applications from all graduating classes; however, the number of HASS Minors received by the Class of 2000 was stable—225, compared to 223 last year. There were 414 applications, compared to 475 last year and 483 in 1997–98. The 225 HASS minors received by members of the Class of '00 were in twenty-one fields. The two most popular fields in terms of applications filed were the same as last year: Economics (151) and Music (51). There were 42 minors in Foreign Languages (17 in French, 14 in German, and 11 in Spanish). Other popular HASS Minors were Writing (25), and Literature and Political Science, with 20 apiece.

The number of MIT undergraduates cross-registered for courses at Harvard decreased in 1999–2000. 204 students took 220 subjects at Harvard, compared to 233 students enrolled in 253 subjects in 1998–99. Last year there was a sizable increase in these enrollments; they seem to fluctuate for no obvious reason. As usual, foreign languages were by far the most popular field of study. 122 of the 220 subjects were in 21 different foreign languages. The three most popular languages were Chinese (19), French (15) and Urdu-Hindi (15). These were followed by Sanskrit (10), Korean (9), and Russian (8). Enrollments in other languages were spread fairly evenly. The most popular fields outside foreign languages were Government (12) and Art/Visual Studies (10).

94 students received the S.B. in SHSS this year, down from 101 last year. Of these, 53 degrees were in Economics (Course 14) and 8 were in Political Science (Course 17). During the same time period, September 1999 through June 2000, a total of 29 students completed the S.B. Degree in Humanities (Course 21). Nine of these received joint degrees, 5 in 21-E and 4 in 21-S. Another 20 received degrees in a specified field within Course 21. Three students received the S.B. in Philosophy and one received the S.B. in Linguistics and Philosophy (Course 24).

The four departments in SHSS had 146 undergraduate majors this year; this figure includes only first degrees. Ninety-three of these are majoring in Economics, and the Political Science Department has 15 majors. Forty students had a Humanities major as their first degree in 1999–2000; of these, 17 were joint majors (11 in 21-E and 6 in 21-S.) Of the specified majors within Humanities, Literature and Writing had the most majors, with 5 each. Nine undergraduates have declared a major in Philosophy or in Linguistics and Philosophy.

Among the more notable honors achieved by SHSS majors this year were:

Boit Manuscript Prize	First Place in Drama, Thomas Cork, '00; First Place in Poetry, Moana Minton, '01
Burchard Scholars	Daniel Berger, '01; Simone Berkowitz, '02; Irena Goldenberg, '01; Douglas Kriner, '01; Laura Moulton, '01; Dawn Pelner, '01; Philip Tan, '01
Chemistry Undergraduate Research Award	Krzystof Rybak, '00
John S. Hollywood Award	Edgar Martinez, '00
I. Austin Kelly III Prizes	Jason Krug, '00, Philip Osafo-Kwaako, '01
Philip Loew Memorial Award	Daniel Jochelson,'00; John McKay, '00; Ivan Middleton, '01
MIT Symphony Orchestra Concerto Competition	Special Mention, Ivan Middleton, '01
Ragnar and Margaret Naess Awards	Dawn Perlner, '01
Phi Beta Kappa	James Berry, '00; Petros Boufounos, '00; Christopher Brocoum, '00; Jasper Chen, '00; Paul Crowley, '00; Anupam Jena, '00; Jason Krug, '00; Stacey Schreiber, '00; Simon Tisminezky, '00
Prize for Excellence in Economics Writing	Cristina Estrada, '01
Prize for Writing Science Fiction	Honorable mention, Anthony Julian, '00
Jeremy D. Sher Award	Christopher Rezek, '00
Louis Sudler Prize	Thomas Cork, '00
Gregory Tucker Memorial Prize	Laurel Smith, '00
Laya and Jerome B. Wiesner Award	Jason Krug, '00; Sean Sutherland, '00

Bette Davis

Table 1. Enrollment In Humanities And Social Science Subjects, 1999–2000

Field	Elective Subjects			HASS-Distribution			Total Enrollment		
	#Subjects	(#Sections)	#Students	#Subjects	(#Sections)	#Students	#Subjects	(#Sections)	#Students
Anthropology	17	(17)	200	5	(5)	159	22	(22)	359
Archaeology	6	(6)	116	1	(1)	31	7	(7)	147
Economics	21	(43)	1,689	3	(3)	56	24	(46)	1,745
Foreign Languages and Literature	65	(98)	968	25	(40)	541	90	(138)	1,509
History	26	(26)	367	14	(14)	296	40	(40)	663
History of Art and Architecture	3	(4)	34	4	(4)	116	7	(8)	150
Linguistics	8	(8)	145	0	(0)	0	8	(8)	145
Literature	35	(37)	326	19	(28)	594	54	(65)	920
Music*	24	(27)	344	8	(14)	377	32	(41)	721
Philosophy	20	(20)	248	6	(6)	372	26	(26)	620
Political Science	25	(25)	264	7	(7)	203	32	(32)	467
Psychology	9	(9)	254	1	(1)	339	10	(10)	593
STS	15	(15)	90	5	(5)	176	20	(20)	266
Theater Arts*	16	(22)	259	3	(3)	37	19	(25)	296
Urban Studies	10	(10)	180	2	(2)	23	12	(12)	203
Visual Arts	8	(8)	75	2	(4)	77	10	(12)	152
Women's Studies	14	(14)	36	4	(4)	41	18	(18)	77
Writing	34	(64)	858	7	(9)	132	41	(73)	990
Other Subjects	4	(4)	33	2	(2)	76	6	(6)	109
Totals	**360**	**(457)**	**6,486**	**118**	**(152)**	**3,646**	**478**	**(609)**	**10,132**

Notes:

1. Figures were obtained from the MITSIS system, which shows the final tally for each class.
2. The numbers shown are for undergraduate subjects which normally satisfy the HASS Requirement; they do not include subjects allowed by petition.
3. (#Sections) refers to the number of autonomous class sections; it does not apply to subjects which meet in a single lecture and divide into discussion sections.
4. For joint subjects, figures are given for the subject number under which students enrolled.
5. HASS-D Language Option subjects (Level III or IV languages) are included in the HASS-D figures

* Music and Theater Arts 6-unit performance subjects are not included in these statistics.

Table 2. Concentrations In All The Fields Of Humanities And Social Science, June 2000

Fields of Concentration	Class of 2003		Class of 2002		Class of 2001		Class of 2000		Totals in Fields	
American Studies	(0)	0	(0)	0	(3)	0	(2)	2	(5)	2
Ancient & Medieval Studies	(0)	0	(5)	0	(3)	1	(7)	7	(15)	8
Anthropology	(0)	0	(7)	1	(17)	4	(37)	33	(61)	38
Archaeology	(0)	0	(4)	0	(4)	0	(3)	3	(11)	3
Black Studies	(0)	0	(0)	0	(1)	0	(3)	3	(4)	3
Comparative Media Studies	(0)	0	(15)	0	(10)	1	(17)	16	(42)	17
Constitutional Tradition	(0)	0	(0)	0	(0)	0	(2)	2	(2)	2
East Asian Studies	(0)	0	(7)	0	(11)	3	(30)	30	(48)	33
Economics	(2)	0	(112)	4	(179)	48	(331)	315	(624)	367
Ethnic Studies	(0)	0	(1)	0	(0)	0	(0)	0	(1)	0
Foreign Languages**	(0)	0	(93)	8	(132)	27	(217)	201	(442)	236
History	(0)	0	(9)	0	(16)	2	(62)	61	(87)	63
History of Art and Architecture	(0)	0	(2)	0	(3)	0	(7)	7	(12)	7
Labor in Industrial Society	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
Latin American Studies	(0)	0	(0)	0	(4)	0	(3)	3	(7)	3
Linguistics	(0)	0	(3)	0	(9)	2	(15)	14	(27)	16
Literature	(0)	0	(26)	1	(38)	8	(50)	45	(114)	54
Middle Eastern Studies	(0)	0	(3)	0	(1)	0	(1)	1	(5)	1
Music	(0)	0	(29)	1	(59)	9	(106)	99	(194)	109
Philosophy	(0)	0	(13)	1	(27)	6	(38)	36	(78)	43
Political Science	(0)	0	(18)	1	(18)	2	(34)	33	(70)	36
Psychology	(0)	0	(10)	0	(28)	9	(62)	61	(100)	70
Religion	(0)	0	(1)	0	(1)	0	(3)	3	(5)	3
Russian Studies	(0)	0	(0)	0	(0)	0	(1)	1	(1)	1
Science, Technology, & Society	(0)	0	(5)	0	(12)	1	(17)	15	(34)	16
Theater Arts	(0)	0	(9)	0	(14)	2	(22)	20	(45)	22
Urban Studies	(0)	0	(5)	0	(15)	2	(25)	24	(45)	26
Visual Arts & Design	(0)	0	(1)	0	(5)	0	(19)	18	(25)	18
Women's Studies	(0)	0	(3)	0	(11)	2	(8)	8	(22)	10
Writing	(0)	0	(15)	0	(30)	5	(53)	51	(98)	56
Special Concentrations	(0)	0	(0)	0	(2)	1	(3)	3	(5)	4
TOTAL	(2)	0	(369)	17	(653)	135	(1178)	1115	(2229)	1267

* The parenthetic figure is the number of proposed concentrations in the given class and field; the figure to its right is the number of these concentrations that have been completed.

** Figures for subfields of Foreign Languages and Literatures are below:

Theory of Language	(0)	0	(2)	1	(0)	0	(2)	1	(4)	2
Chinese	(0)	0	(14)	1	(17)	2	(27)	27	(58)	30
ESL	(0)	0	(2)	0	(0)	0	(4)	4	(6)	4
French	(0)	0	(16)	0	(22)	3	(54)	48	(92)	51
German	(0)	0	(17)	3	(12)	5	(26)	24	(55)	32
Japanese	(0)	0	(11)	0	(27)	4	(33)	32	(71)	36
Other Languages	(0)	0	(3)	0	(5)	0	(5)	4	(13)	4
Spanish	(0)	0	(28)	3	(46)	11	(62)	58	(136)	72
SILC	(0)	0	(0)	0	(3)	2	(4)	3	(7)	5
Totals	**(0)**	**0**	**(93)**	**8**	**(132)**	**27**	**(217)**	**201**	**(442)**	**236**

Table 3. Undergraduate Majors

Year	Economics	Humanities*	Linguistics & Philosophy	Political Science	Total
1990-91	115	64	13	44	236
1991-92	81	75	12	35	203
1992-93	75	64	5	41	185
1993-94	79	58	5	38	180
1994-95	81	56	8	40	185
1995-96	101	49	6	19	175
1996-97	99	31	8	31	169
1997-98	111	41	12	30	194
1998-99	91	55	6	18	170
1999-00	93	29	14	15	146

*These figures do not include double majors who registered first in a course other than Humanities. (If you include double majors, the figure is 54.)

Table 4. Graduate Students

Year	Economics	Hist & Soc Study of Sci & Tech	Linguistics & Philosophy	Poli Sci	*Comparative Media Studies	Total
1990-91	134	13	61	154		362
1991-92	139	17	53	160		369
1992-93	149	21	57	154		381
1993-94	143	24	50	138		355
1994-95	130	29	65	122		346
1995-96	138	27	63	107		335
1996-97	132	28	68	123		351
1997-98	122	31	65	120		338
1998-99	121	33	69	116		339
1999-00	129	31	68	90	5	323

*Comparative Media Studies (CMS) – 1999-00 is the first year of the new graduate program.

Table 5. Applicants For Classes Of 2000–2003

FIELD	TOTAL APPLICATIONS
Anthropology	6
Comparative Media Studies	9
Economics	151
Foreign Languages	
French	17
German	14
Spanish	11
History	15
History of Art & Architecture	4
Linguistics	11
Literature	20
Music	51
Philosophy	7
Political Science	20
Public Policy	3
Psychology	13
Regional Studies Minor Programs	
African & African Diaspora	0
East Asian Studies	14
European Studies	1
Latin American Studies	3
Middle Eastern Studies	0
Russian Studies	1
Science, Technology & Society	2
Theater Arts	9
Urban Studies and Planning	4
Women's Studies	3
Writing	25
Total Minor Applications	**141**

DEPARTMENT OF ECONOMICS

We are currently ranked as the best economics department in the world. Our goal is to stay there.

Several department faculty and graduates have received important honors. In October 1999, Robert Mundell (Ph.D.'56) was awarded the Nobel Prize in Economic Science. In January 2000, Andrei Shleifer (Ph.D. '86) was awarded the John Bates Clark medal of the American Economic Association. This award is presented every other year to an outstanding economist under the age of 40. In March 2000, lifelong faculty member and Nobel laureate Robert Solow was awarded the National Medal of Science by President Clinton.

Graduates of the MIT Economics Department continued to play an important role in many aspects of economic policy-making in the last year. Lawrence Summers was sworn in as Secretary of the Treasury in early July 1999. Stanley Fischer (Ph.D. '69) served as Acting Managing Director of the International Monetary Fund for several months in early 2000. In January 2000, Joseph Stiglitz stepped down from his position as Chief Economist at the World Bank. Martin Bailey (Ph.D. '72) began a term as chairman of the Council of Economic Advisors in mid-1999.

Closer to home, at the end of a day-long conference devoted to celebrating Professor Frank Fisher's 65th birthday, Dennis Carlton (Ph.D.'75) announced that he and his wife, Jane Berkowitz Carlton, had decided to endow a new chair in Microeconomics. Professor Fisher, Dennis' thesis advisor, is the first holder of the Carlton chair.

And a number of faculty and students have received important honors and awards. Professor Ricardo Caballero was named the Ford International Professor of Economics, and Assistant Professor Sendhil Mullainathan was named as the first holder of the Mark Hyman Jr. Career Development Chair. Associate Professors Susan Athey and Jaume Ventura both received Sloan Foundation Fellowships, and Professor Athey also received a prestigious "NSF Career award." One of our graduate students, Chris Spohr, was one of three Karl Taylor Compton Prize winners in May 2000. This Institute-wide prize honors students for outstanding achievement in citizenship and devotion to MIT.

Next year's entering class of 36 Ph.D. students will include 15 international students and 14 women (39%). Eleven of our entering class have National Science Foundation Fellowships.

Undergraduate enrollment decreased this year by 7%. This is a dip on a clear positive trend in enrollment. The increase is of nearly 65% over the last fifteen years.

There were 120 undergraduate majors in economics (28 of whom are double majors), 151 undergraduate minors, and 367 concentrations completed in economics. 56 students received their S.B. in economics in 1999.

Our graduate students on the job market did well this year, with 35% receiving assistant professorships in top 20 economics departments and business schools. A total of 65% accepted academic positions, 17.5% took positions in international organizations, and 17.5% obtained positions in the private sector.

The World Economy Laboratory (WEL), the fundraising unit in the Department of Economics directed by Professor Rudi Dornbusch, continued to provide resources for the department. WEL conferences were held in New York and Washington DC during the academic year. These conferences communicate research findings to a broad audience in business, the economic press, academia and government, and to establish a policy dialogue beneficial to both sides. WEL also made resources available to support policy research for several graduate students and junior faculty. Memberships in WEL continue to grow with each year and allow WEL to continue to support a wide array of student and faculty activities.

FUTURE PLANS

Our department is doing well. The general atmosphere is warm and friendly, the research atmosphere is exciting, and faculty members are very productive. Our junior faculty are particularly outstanding, and we see this as our main strength for the future. Some fields where we were less strong, labor economics and development in particular, are in sharp expansion and attracting an increasing number of students. We feel we still have two major senior needs, one in theory and one in macroeconomics. We have two search committees looking at potential candidates. Given our traditional strategy of going after "young senior" researchers, we also have a search committee looking at young researchers across fields. We expect to make offers in the fall of 2000.

At the same time, competition from other departments is becoming more intense, and our competitors are often bigger and richer. We feel that, to thrive in the long run, the department must increase in size, both by expanding its core, and the number of faculty members in major fields. We also have to secure one of our main assets, the quality of our student pool, by increasing the number of fellowships we can offer. This is all the more urgent, given the decline in many of the traditional external sources of such fellowships.

PERSONNEL

Professor Acemoglu was promoted to Professor. Associate Professor Dora Costa was awarded tenure. David Autor, Esther Duflo, and Xavier Gabaix joined the faculty as Assistant Professors.

Victor Chernozhukov and Muhamet Yildiz will join the faculty as Assistant Professors as of July 1, 2000. Yildiz received his Ph.D. from Stanford Graduate School of Business and is a theorist with research interests in strategic bargaining, bargaining procedures, and the results of strategic bargaining. Chernozhukov also received his Ph.D. from Stanford Graduate School of Business and is an econometrician who, in his thesis, developed a statistical approach for estimating boundaries for economic data.

Professor Paul Krugman and Assistant Professor Robin Wells resigned effective June 30, 2000. They will both assume positions in the Economics Department at Princeton University.

There were six visiting faculty for all or part of the 1999–2000 academic year. Visiting Professor Jean Tirole taught a topics course in industrial organization. Visiting Professor Roger Brinner taught macroeconomics. Visiting Professor Mathias Dewatripont taught microtheory. Visiting Professor Eric Maskin taught game theory. Visiting Professors Philippe Weil and Francesco Giavazzi both taught macroeconomics.

The department would like to increase the proportion of women and minorities in the department. All search committees are instructed to identify outstanding women and minority candidates as part of their search process. As part of the regular recruitment process for junior faculty, the department solicited/received 214 CVs. Twenty-eight candidates (including seven women) were selected for interviews. All candidates were interviewed by at least two members of the faculty. Subsequently, eight candidates were invited to come to MIT and present a seminar. As a result of this process, three offers were made, one of them to a woman, Monica Piazzesi, from Stanford. Two of the offers were accepted. Monica Piazzesi, facing a joint career choice, decided to go to Chicago instead.

HONORS AND AWARDS

Professor Acemoglu was invited to give the keynote address at the European Labor Economics Association meetings. He also became the editor of a new Internet economics journal, the QR Journal of Macroeconomics.

Professor Athey was named a Hoover Institution National Fellow, as well as a Sloan Foundation Research fellow. She received a NSF career award, became co-editor of the QR Journal of Theoretical Economics and co-editor of the Journal of Economics and Management Strategy. She was also on the Program Committees for the 8th World Congress of the Econometric Society and the Winter Meetings of the Econometric Society.

Professor Autor was elected a Faculty Research Fellow for the National Bureau of Economic Research and a Faculty Affiliate of the Joint Center for Poverty Research, University of Chicago/Northwestern University. He also received the MIT James H. Ferry Fund Grant for Innovation in Research Education.

Professor Abhijit Banerjee received a Guggenheim Fellowship.

Professor Olivier Blanchard was a member of the Committee on Honors and Awards for the American Economic Association, gave the Horowitz Lectures at Tel Aviv and Hebrew University, and gave the Tinbergen lecture in Amsterdam.

Professor Caballero is the 1999 recipient of the annual award granted by the Foundation of Economics and Business at Catholic University of Chile to one of its alumni, was elected Graduate Teacher of the year in the Department of Economics, and was named a Ford International Professor of Economics.

Professor Peter Diamond received a Fulbright Fellowship.

Professor Dornbusch received the Concord Prize in Krefeld, Germany.

Professor Duflo was invited to join the MacArthur Foundation Network on the Effects of Inequality on Economic Performance.

Professor Glenn Ellison was appointed editor of Econometrica.

Professor Fisher gave the Eleventh Annual Joseph L. Lucia Public Policy Lecture at Villanova University, the Fourth Annual Gideon Fishelson Memorial Lecture at Tel Aviv University, and was named the inagural holder of the Jane Berkowitz Carlton and Dennis William Carlton Chair in Microeconomics.

Professor Gabaix became a member of Sigma Xi.

Professor Bengt Holmstrom gave the Wicksell lectures at Stockholm School for Economics, and the Astra-Ericsson lecture at the Institute for Industrial Economics in Stockholm.

Professor Paul Joskow was the keynote speaker at the Annual Meeting of the International Society for New Institutional Economics, and was appointed to the Bogen Visiting Chair at Hebrew University.

Professor Mullainathan was appointed to the Mark Hyman, Jr. Career Development Chair, beginning July 2000, and was appointed to be the Zvi Griliches National Fellow by the National Bureau of Economic Research for 2000–2001. He also received a National Science Foundation Grant for 2000–2002, and was awarded the Graduate Student Award for Outstanding Faculty Member in the MIT Economics Department for 2000.

Professor Whitney Newey received the College Honored Alumni Award by the College of Family, Home, and Social Sciences at Brigham Young University.

Professor James Poterba was the inaugural Review of Economics and Statistics lecturer in March of 2000, was awarded the Duncan Black Prize from the Public Choice Society for Outstanding Paper in Public Choice, and was the Institute for Fiscal Studies Annual Lecturer in London.

Professor Nancy Rose was elected to the American Economic Association Executive Committee, and was elected Teacher of the Year by the MIT Undergraduate Economics Association.

Professor Emeritus Paul Samuelson received the John R. Commons Award from Fordham University at the AEA meetings.

Professor Peter Temin gave the John R. Hicks Lecture at Oxford University, and is President-elect of the Eastern Economic Association.

Professor Ventura received a Sloan Fellowship for the 2000–2001 year, and was appointed to the Pentti Kouri Career Development Chair, beginning July 1999.

RESEARCH ACHIEVEMENTS

Professor Acemoglu's paper "Productivity Differences" (joint with Fabrizio Zilibotti) is forthcoming in the *Quarterly Journal of Economics.*

Professor Joshua Angrist's paper "The Interpretation of Instrumental Variables Estimators, with an Application to the Demand for Fish" (joint with Guido Imbens and K. Graddy) was published in the *Review of Economic Studies.*

Professor Athey's paper "Mentoring, Discrimination, and Diversity in Organizations" will appear in the September issue of the *American Economic Review.*

Professor Autor's paper "Changes in the Wage Structure and Earnings Inequality" was published in the Handbook of *Labor Economics.*

Professor Banerjee's paper "Inequality, Control Rights and Rent-Seeking: Sugar Cooperatives in Maharashtra" written with D. Mookherjee, K. Munshi, and D. Ray is forthcoming in the *Journal of Political Economy.*

Professor Blanchard published "The Role of Shocks and institutions in the rise of European Unemployment: The Aggregate Evidence" a joint paper with Justin Wolfers in the *Economic Journal.*

Professor Caballero prepared a paper entitled "Aggregate Volatility in Modern Latin America: Diagnostic, Analysis, and Policy Recommendations" for the World Bank's fiscal year 2000 flagship report "Dealing with Economic Insecurity in Latin America."

Professor Costa's paper "Power Couples: Changes in the Locational Choice of the College Educated, 1940–1990" (joint with Matthew Kahn) is forthcoming in the *Quarterly Journal of Economics.*

Professor Dornbusch has a book titled *Free Markets, Hard Money, and a Bit of Luck* forthcoming.

Professor Duflo's joint work with Professor Banerjee "Reputation Effects and the Limits of Contracting: A Study of the Indian Software" is forthcoming in the *Quarterly Journal of Economics.*

Professor Ellison's paper "The Neo-luddite"s Lament: Excessive Upgrades in the Software Industry" (joint with Drew Fudenberg) was published in the *RAND Journal of Economics.*

Senior Lecturer Sara Ellison published her joint work with Professor Ellison "A Simple Framework for Nonparametric Specification Testing" in the *Journal of Econometrics.*

Professor Fisher has an article forthcoming in the *Journal of Reprints of Antitrust Law and Economics.*

Professor Gabaix's paper "Zipf's law for cities" was published in *the Quarterly Journal of Economics.*

Professor Jonathan Gruber published "Cash Welfare as a Consumption Smoothing Mechanism for Single Mothers" in the *Journal of Public Economics.*

Professor Gerald Hausman has an article titled "Microeconometrics" forthcoming in the *Journal of Econometrics.*

Professor Holmstrom has a joint work with Visiting Professor Tirole forthcoming in the *Journal of Money, Credit, and Banking* titled "Liquidity and Risk Management."

Professor Joskow's article "Deregulation and Regulatory Reform in the U.S. Electric Power Sector" is forthcoming in the volume *Deregulation of Network Industries: The Next Steps.*

Associate Professor Guido Kuersteiner is in the process of publishing his paper "Optimal Instrumental Variables Estimation for ARMA Models."

Professor Mullainathan's joint work with M. Bertrand "Are CEOs Rewarded for Luck? The Ones Without Principals Are" is forthcoming in the *Quarterly Journal of Economics.*

Professor Newey's article "Tax Reform Evaluation Using Nonparametric Methods: Sweden 1980–1991" (joint with S. Blomquist and M. Eklof) is forthcoming in the *Journal of Public Economics.*

Professor Poterba published "New Evidence on the Money's Worth of Individual Annuities" in the *American Economic Review.*

Professor Rose's article with C.D. Wolfram "Has the 'Million-Dollar Cap' Affected CEO Pay?" is forthcoming in the *American Economic Review Papers and Proceedings.*

Associate Professor David Spector published "Rational Debate and One-Dimensional Conflict" in the *Quarterly Journal of Economics.*

Professor Temin published "The Industrialization of New England, 1830–80" in a volume edited by him titled *Engines of Enterprise: An Economic History of New England.*

Professor William Wheaton's article "Decentralized Welfare: Will There be Under Provision?" is forthcoming in the *Journal of Urban Economics.*

More information about the department can be found on the World Wide Web at http://web.mit.edu/economics/www/.

Olivier Blanchard

ANTHROPOLOGY

The MIT Anthropology Program is dedicated to advanced research and publication in cultural anthropology; to undergraduate teaching that opens students to the fundamentals of cross-cultural understanding and social thought; and to graduate teaching in the history and social study of science and technology. Our undergraduate subjects cover a wide range, with special strengths in the study of the contemporary world and the social context of technology. The anthropology faculty maintains strong ties with other programs in the School of Engineering and the School of Humanities, Arts, and Social Sciences, including Women's Studies, Latin American Studies, the Technology Policy Program, the History Faculty, and Science, Technology, and Society.

In 1999–2000, after hiring new faculty members in the previous two years, the Anthropology Program returned to an approximation of its previous strength, allowing it to function more easily as an academic unit and to offer a full complement of subjects. We look forward to further strengthening and consolidating our curriculum and to possible additional growth in the coming year.

In June of 2000 Professor James Howe completed his term as head of the Anthropology Program. He will be succeeded by Professor Susan Slyomovics, who was on leave in Morocco throughout 1999–2000.

PROGRAM CONTRIBUTIONS

The committees, boards, and task forces at MIT on which Anthropology Program members served this year include the Women's Studies Steering Committee, the Gender Equity Committee, the Siegel Prize Committee, the Public Service Summer Fellowship Committee, and the steering committee of the doctoral program in the History and Social Study of Science and Technology (HSSST). Professor Jean Jackson headed the Humanities Overview Committee.

Professors Michael Fischer, Jackson, Howe, and Associate Professor Hugh Gusterson all play active roles in teaching, advising, and administration of the HSSST doctoral program, sponsored by the STS, History, and Anthropology Programs. Professor Arthur Steinberg continues as director of the Integrated Studies Program.

Outside of MIT, Professor Gusterson continues to serve on the Hanford History Advisory Committee, Professor Jackson on the advisory board of Cultural Survival and the editorial board of the *Journal of Latin American Anthropology*. Professor Slyomovics serves on seven boards. Professor Howe has been nominated to the board of Native Lands and is President of the non-profit organization, Eagle Light Caretakers.

SCHOLARSHIP

A small sampling of presentation by members of the Anthropology Program faculty during 1999–2000 gives some sense of the wide range of their research interests as well as their shared viewpoint and focus. In August of 1999, Professor Howe ran a day-long workshop in Panama City for an organization of Indian scholars called Koskun Kalu in which he presented the principal methods and results of his study of their people's history. In September Professor Gusterson gave a paper at the Center for International Security Studies of York University, Canada entitled "Clashes of Cultures: An Anthropologist Reads Samuel Huntington." Assistant Professor Christine Walley presented "'Culture' and the Global Debates over Female Genital Surgeries," in a special panel at the meetings of the American Anthropological Association in November 1999. In May of 2000 Professor Jackson presented a paper called "Pain Voices" at the Houghton Mind/Brain/Behavior Colloquium on Pain and its Transformations at Harvard University. The same month Professor Slyomovics attended a conference in honor of Clifford Geertz in Sefrou, Morocco, presenting a paper entitled "Récits d'autorité et écrits autorisés: approaches ethnographiques des détenus politiques marocains."

Professor Jackson's book, *"Camp Pain": Talking with Chronic Pain Patients,* was published this year by the University of Pennsylvania Press. Professor Slyomovics has two edited volumes in press, *The Living Medina in the Maghrib*, and *Women and Power in the Middle East.* Professor Gusterson's book, *Simulating Armageddon*, is also in press. All program members have book projects at various stages of development, as well as a number of articles and book chapters published or forthcoming this year.

RECOGNITION AND PROMOTION

The achievement of three faculty members received notable recognition. Professor Slyomovics' book, *The Object of Memory*, published in 1998, won two prestigious awards, the Chicago Folklore Prize and the Albert Hourani Book Award of the Middle Eastern Studies Association for the best book on the Middle East published that year. Professor

Walley's doctoral thesis was awarded the Dean's Outstanding Dissertation Award in the Social Sciences from the Graduate School of Arts and Sciences of New York University. Professor Gusterson received a well-deserved promotion to the rank of tenured associate professor.

More information on the Anthropology Program can be found on the World Wide Web at http://web.mit.edu/anthropology.

James Howe

FOREIGN LANGUAGES AND LITERATURES

Foreign Languages and Literatures (FLL) is dedicated to providing MIT students with the tools for a sensitive and successful involvement in the global community by contributing to the internationalization of their MIT education. During the academic year 1999–2000, FLL faculty continued to provide national and international leadership in the fields of foreign language pedagogy, technology in the humanities, and literary and cultural studies, while demonstrating their commitment to excellence in education within the Institute.

Several members of the section were recognized in their fields. Professor of French Studies Isabelle de Courtivron became Section Head in January 2000 and was named Distinguished Alumna of Brown University in the Spring. Assistant Professor of Chinese Emma Teng received the J. Paul Getty Postdoctoral Fellowship Award for 2000–01. Lecturer in French Sabine Levet was named the Vice President of the American Council on the Teaching of Foreign Languages (ACTFL) Special Interest Group on the Teaching and Learning of Culture, and Senior Lecturer Douglas Morgenstern was named Chair of the Modern Language Association (MLA) Committee in Computers and Emerging Technologies in Teaching and Research. Associate Professor of German Bernd Widdig, Senior Lecturer in French Gilberte Furstenberg, and Lecturer in Spanish Adriana Gutierrez-Gonzalez were on leave during the Spring 2000 semester.

FLL faculty and lecturers have, for the past several years, been actively developing materials and new technology to enhance the teaching of foreign languages and culture. This year saw the start of the Daimler Chrysler Research Project (PI, Research Associate Kurt Fendt in collaboration with many members of the FLL faculty). The Consortium for Language Teaching and Learning remains a strong supporter of various FLL multimedia projects, having provided new campus-based funding for the web-based project Immigrant Voices: Stories from Hispanic Communities in Boston (co-PIs, Lecturers in Spanish, Margarita Ribas Groeger and Gutierrez). Lecturer in French Johann Sadock also received campus-based Consortium funds for his project Au-delà du regard: recontres multiethniques, a web-based module that focuses on the changing face of French society as a result of an increasingly racially and ethnically diverse youth. This year, the Consortium's sole recipient of Consortium-wide funding was Cultura, a Multimedia/Hypermedia Cross-Cultural Project for CD-ROM and the Web (PI, Senior Lecturer Furstenberg). This project also received a grant from the Marion and Jasper Whiting Foundation. Lecturer in German Monika Totten's interactive web project, Kultura Germany, also received support from the Consortium. StarFestival, a CD-ROM-based curriculum about Japanese Culture (PI, Shigeru Miyagawa, Professor of Japanese and Linguistics), has been adopted system-wide in grades K-5 by the Boston Public Schools for the school year 2000–01.

Research in the areas of literary and cultural studies, linguistics and language pedagogy continues to be of the highest caliber and is regularly published in internationally respected journals. Professor de Courtivron was guest editor for *SITES: The Journal of 20th Century Contemporary French Literature* Volume 4 Issue 1 and wrote an article for the issue on "Midlife Memoirs and the Bicultural Dilemma." Visiting Associate Professor of French Odile Cazenave's book, *Rebellious Women: The New Generation of Female African Novelists* was published by Lynne Rienner Publishers in September 1999. In addition, five of her articles were published this year, among them "Writing New Identities: The New African Diaspora in France," appeared in *Literature of Immigration in France*; Calixthe Beyala's "Parisian Novels: An Example of Globalization and Transculturation in French Society," was published in *SITES: The Journal of 20th Century Contemporary French Studies*; and "Roman africain au féminin et immigration: dynamisme du devenir," appeared in *Changements au féminin en Afrique Noire, Vol. II: Littérature.* Professor of Second Language Acquisition and Linguistics Suzanne Flynn continues as co-editor of the *Syntax Journal.* Senior Lecturer Furstenberg's CD-ROM and Pedagogical Guide "Dans un quartier de Paris" was published by Yale University Press in September 1999. Lecturer Levet co-authored the Pedagogical Guide. Senior Lecturer Furstenberg also wrote a chapter in the book "Interactive Learning: Vignettes from America's Most Wired Campuses" which was published by Arker Publishing Company. Professor Miyagawa's work Causatives appeared in the *Handbook of Japanese Linguistics* and his work "Make as a Light Verb and the Notion of CAUSE" was published in *Linguistics: In Search of the Human Mind.* Professor Teng wrote an article for *Harvard Journal of Asiatic Studies* entitled "Taiwan as Living Museum: Tropes of Anachronism in Late-Imperial Chinese Travel Writing." The paperback edition of Professor of French and Film Studies Edward Baron Turk's book *Hollywood Diva: A Biography of Jeanette MacDonald* was published by the University of California Press. Senior Lecturer in Chinese Julian Wheatley's article "Classroom Testing" appeared in *Mapping the Course of the Chinese Language Field,* a publication of the Chinese Language Teachers Association. He also co-authored the article "Languages in Contact: The Case of English and Burmese" published in the *Journal of Burma Studies.*

This year, FLL's Center for Bilingual and Bicultural Studies (CBBS) brought distinguished author Eva Hoffman to MIT as a Visiting Professor. Her works include *Lost in Translation: A Life in a New Language* and *Shtetl: The Life and Death of a Small Town and the World of the Polish Jews*. In addition to heading a panel discussion at MIT, Visiting Professor Hoffman taught the course "Where East Meets West: Contemporary Eastern European Literatures." FLL also co-sponsored talks by noted authors Friedrich Christian Delius, Andreï Makine and George Steiner.

FLL faculty were invited to numerous national and international conferences. Professor de Courtivron was invited to speak and present a paper at Harvard University's Center for European Studies Colloquium on France and Europe. Lecturer in Italian Daniele Benati was invited to speak at the Italian Consulate Conference in Vienna, Austria and in Modena, Italy. Visiting Professor Cazenave was invited to be moderator at the African Festival, Fest' Africa in Lille, France. She was also a co-moderator of a discussion at the Boston University Festival of Francophone Expression and was Panel Chair at the International Council of Francophone Studies (CIEF) Convention held in Tunisia. Both Jane Dunphy and Mary Christie, Lecturers in ESL, presented papers at the Association for Business Communication Conference in Los Angeles, CA. Lecturer Dunphy also presented her paper "Humor Across the Curriculum" at the Teachers of English to Speakers of Other Languages (TESOL) 2000 Convention. Research Associate Fendt made a presentation at the week-long workshop "Digital Media in Science Education" organized by the University of Saarbrücken, Germany. Senior Lecturer Furstenberg presented her "Dans Un Quartier de Paris" project at the annual Foreign Language Association of North Carolina (FLANC) Conference. Elizabeth Garrels, Professor of Spanish and Latin American Studies and Lecturer Groeger co-organized the Luisa Campuzano Lecture in September 1999, a project sponsored by FLL in conjunction with MIT's Women Studies Program, Wellesley College, and Harvard University's Rockefeller Center for Latin American Studies. Lecturer Levet was a presenter at numerous conferences including the Computer Assisted Language Instruction Consortium (CALICO) symposium and the International Association for Language Learning Technology (IALL) conference. Senior Lecturer Morgenstern served as presider and organizer of an invited panel on "Evaluating and Supporting Academic Work in the Digital Age" at the MLA Convention. Lecturer in Japanese Yoshimi Nagaya taught at the Teacher's Training Workshop at Bryn Mawr College. Associate Professor of Hispanic Studies Margery Resnick gave a talk at the MIT Alumni Club in New Mexico entitled, "This is Not Your Father," as well as a talk in Alicante, Spain on "Challenges and Perspectives on Women's Studies Programs." Lecturer Sadock co-organized an "Evening on Multiculturalism in France" with the Cultural Services department of the French Consulate in Boston. Professor Teng presented "Photographs of a Vanished City" at the Association of Chinese Comparative Literature Conference in Vienna in June 1999. She also presented papers at the Contested Modernities Conference, the Fairbanks Center Director's Seminar, the Association of Asian American Studies Convention, and the International Conference on Art, Literature, and Travel. Lecturer Totten organized and introduced Katja Behrens' reading at the Goethe Institute in Boston and also participated in the Berlin Seminar with contemporary German writers. Professor Turk was the organizer and moderator for the panel on Independent Cinema for Communications Forum. He also moderated the panels for the Media in Transition Conference on "Aesthetic Consequences of New Media" and "Rethinking Literacy." Professor Widdig gave a number of talks, including "Internationalizing Education: The MIT-Germany Program" at the Second International Engineering Education Colloquium at the University of Rhode Island. Professor Widdig was invited to speak at a number of other conferences as well, including the German Studies Association Twenty-Third Annual Conference and the Sexual Revolution Conference held at Old Dominion University. Senior Lecturer Wheatley, along with Lecturers in Chinese Tong Chen and Nyan-Ping Bi each presented papers at the ACTFL Conference in Dallas in November 1999. In addition to chairing that panel, Senior Lecturer Wheatley also participated in the Association of Asian Studies Conference in San Diego.

Faculty and lecturers also participated in programs organized at MIT. Professor de Courtivron gave a talk at Parents' Weekend and for the Visiting Committee at MIT. She also organized events sponsored by CBBS. Professor Turk was the guest speaker at Burchard Fellows Dinner on "Art, Censorship, and the Holy Virgin Mary." He also presented two films to the International Film Club: "Two Films by Peter Greenaway" and "Murnau's *Tabu*." This year, Professor Flynn co-organized two conferences at MIT: Generative Approaches to Second Language Acquisition in May, and Language for Seven Generations held in June. Professor Resnick continued her active participation in the Association of MIT Alumnae (AMITA) Oral History project. Associate Professor of Hispanic Studies Nicolas Wey-Gomez organized talks by artists-in-residence Guillermo Gomez-Peña and Carlos Sifuentes. Senior Lecturer Furstenberg acted as moderator of the panel at the Center for Media Studies (CMS) Conference. Senior Lecturer Morgenstern co-organized the Consortium Workshop on Advanced Spanish Language Instruction.

Members of the FLL faculty also contribute to MIT through their service on a number of Institute-wide committees: The Committee on Undergraduate Programs, the Equal Opportunity Committee, the Burchard Scholars, the Board of

Directors of MIT Professional Programs, the Eloranta Committee, the Committee on Corporate Relations, the Arts Council Advisory Committee, the Campus Committee on Race Relations, the Committee on the Writing Requirement, the Women's Studies Steering Committee, the Phi Beta Kappa Selection Committee, the MacVicar Fellow Selection Committee, the Faculty Committee on the Library System, and the Committee on Curricula, among others. Professor Resnick has also just completed her second year as Chair of the Program in Women Studies.

FLL has maintained its commitment to making full-time appointments and to attracting qualified candidates from minority groups. In order to achieve these goals, FLL has targeted historically black colleges and universities and has advertised in journals and association web sites focusing on the minority community.

While the number of majors in FLL remains low at two, the number of minors (52) and the number of concentrators (416) has remained relatively stable. Spanish continues to have the largest enrollments at 511; followed by English as a Second Language, 297; Japanese, 282; Chinese, 282; French, 257; German, 191, and Italian, 100. Enrollments in Studies in International Literatures and Cultures (cross-cultural language and culture subjects taught in English) are subsumed under the language group to which the instructor belongs.

More information about this section can be found on the World Wide Web at http://web.mit.edu/fll/www/.

Isabelle de Courtivron

HISTORY

The mission of the History Faculty is to promote advanced research and undergraduate teaching in a broad range of fields, including American, Ancient, East Asian, European, Latin American, Middle Eastern, and Russian history. The Faculty includes joint appointments in Urban Studies and in Science, Technology, and Society, and it participates in the joint Ph.D. program in the History and Social Study of Science and Technology.

Professor John Dower's *Embracing Defeat: Japan in the Wake of World War II* continued to garner enthusiastic praise from popular and scholarly reviewers. In addition it received a number of prestigious literary awards, including the National Book Award for Non-fiction, the Pulitzer Prize in General Non-fiction, the *Los Angeles Times* Book Prize in History, and the Bancroft Prize for "distinguished works in American history and diplomacy." Professor Pauline Maier's "The Origins and Influence of Early American Local Self-Government: *Democracy in America* Reconsidered," was published in an edited volume on *Dilemmas of Scale in America's Federal Democracy*. Associate Professor Anne McCants' paper on "The Not-So-Merry Widows of Amsterdam, 1740–1782" appeared in the *Journal of Family History*. Assistant Professor Meg Jacobs' paper "'Democracy's Third Estate:' New Deal Politics and the Construction of a 'Consuming Public'" was published in *International Labor and Working Class History*. Professor Bruce Mazlish published "Invisible Ties: From Patronage to Networks" in *Theory, Culture and Society*. Professor Harriet Ritvo's essay, "Science as Literature, Science as Text," appeared in the *Journal of Victorian Culture*.

Professor Mazlish gave the keynote address at the Conference on Paradigms in World History: Global Studies and World History. Professor Peter Perdue spoke on "Frontier Administration in Eighteenth-Century China: Empire and Nation in Comparative Perspective" at the Sabanci University Center for Political Economy in Istanbul. Associate Professor Jeffrey Ravel presented a paper on "Gender, Enlightenment, and Revolution in Two Eighteenth-Century Biographies" at the Society for French Historical Studies, and continued work on two electronic databases of French theater in the seventeenth and eighteenth centuries. Professor Ritvo spoke on "Environmental Reporting in Victorian Periodicals" at the University of Leeds. Professor Jacobs gave a paper on "Consumerism and Economic Policymaking in the Twentieth-Century U.S." at Churchill College, Cambridge. Professor Maier served as lecturer and consultant for the PBS series "A Biography of America." Professor McCants presented a paper on "The Transmission of Assets and Family Networks" at the European Social Science History Conference, and Associate Professor Heather Cox Richardson presented a paper on "The 1871–1873 Tax Crisis and the Denigration of African-American Labor" at the conference of the Southern Historical Association. Professor Philip S. Khoury, Dean of the School of Humanities and Social Sciences delivered the commencement address "Leadership in the New Technological Age" at the American University of Beirut.

Assistant Professor Lora Wildenthal was promoted to untenured Associate Professor on the basis of high evaluations for her manuscript *German Women for Empire* (forthcoming from Duke University Press) and of her strong contributions to the curriculum in modern European history. Joshua Sosin was appointed Assistant Professor in the field of ancient history. He received his doctorate in Classical Studies from Duke University for a dissertation on "Perpetual Endowments in the Hellenistic World: A Case-Study in Economic Rationalism." Professor Jacobs spent 1999–2000 as the Newcomen Postdoctoral Fellow in Business History at the Harvard Business School.

Professors Maier, Mazlish, Perdue, and Ritvo, along with Associate Professors Richardson and Elizabeth Wood participated in the joint Ph.D. program in the History and Social Study of Science and Technology by teaching graduate seminars, setting general examinations, and supervising dissertations. Professors Dower, Ritvo, and Khoury advised Harvard graduate students in Japanese, British, and Middle Eastern history respectively. Professor Ravel served on the Curriculum Committee of the new graduate program in Comparative Media Studies.

History enrollments totaled 292 in the fall semester and 455 in the spring. Daniel Collarini completed a thesis on "The Effect of the MIT Non-violent Student Protest Movement on MIT Educational and Research Policies, 1967–1970" and Jaie Pizzetti completed one on "Heart of the Commonwealth: The Men of the Fifteenth Regiment Massachusetts Volunteer Infantry and the Civil War, 1861–1864." Professor Richardson advised both theses. Nine seniors graduated with minors in History. Three new subjects were offered: 21H.117, Race, Robbers, Rodeos: America from 1865–1900 (Richardson); 21H.916, The History of Human Rights (Wildenthal); and 21H.920, Contemporary Global History (Mazlish).

Three faculty members led freshman advisor seminars: Professor Khoury on "Conflict and Peace in the Contemporary Middle East," Professor McCants on "A Brief History of Cosmology," and Professor Ritvo (in

collaboration with MIT Museum Director Jane Pickering) on "How to Build Your Own Museum." Professors McCants, Ravel, Ritvo, and Richardson supervised UROP projects.

Professor Maier served as the Chair of the Edgerton Faculty Achievement Award Selection Committee and as a member of the Faculty Policy Committee. Professor Richardson was a member of the HASS Overview Committee. Professors Wood, McCants, and Wildenthal participated in the Women's Studies Program. Professor Wildenthal directed the Truman Scholarship Committee. Professor McCants served as president of MIT's Phi Beta Kappa chapter. Two historians were housemasters: Professor McCants of Green Hall, and Associate Professor William Watson of Baker House.

The Sahin Lecture Series for 1999–2000 included the following presentations: Laurel Ulrich on "'The First, Second, and Last Scenes of Mortality': Decoding an Eighteenth-Century Embroidery" and Janet Browne on "Scientific Celebrity: Charles Darwin in Caricature." Professor Mazlish again jointly organized the monthly meetings of the History and Literature Workshop, and Dean Khoury directed the Bustani Seminar on Middle Eastern Studies.

More information about the History Faculty can be found on the World Wide Web at http://web.mit.edu/history/www/.

Harriet Ritvo

LITERATURE

Academic year 1999–2000 saw the arrival of our first graduate students in Comparative Media Studies, a joint program sponsored by Literature, Foreign Languages and Literatures, and the Program in Writing and Humanistic Studies. The CMS program, which offers an S.M. degree, is strongly based in the humanities with broad participation from other departments and schools. The new degree program combines a scholarly focus on the history and analysis of new and old media (from manuscript and early print to digital) with hands-on practical experience in industry and in MIT's multimedia educational projects. Professor of Literature and Comparative Media Studies Henry Jenkins directs the program, and Literature faculty participate at all levels of this exciting new endeavor.

William Uricchio, currently at the university of Utrecht, Netherlands, will be appointed Professor of Comparative Media Studies, a joint appointment in Literature and Foreign Languages and Literatures, beginning July 1, 2000. Professor Uricchio is a media historian and theorist with research interests in early cinema, the history of the nickelodeon, German television and other areas.

This year, Professor Stephen Tapscott held an appointment at the University of Lodz, Poland, as Fulbright Distinguished Visiting Professor of American Studies. Professor Ruth Perry served as President of the American Society for Eighteenth Century Studies and held a Fellowship at the Rockefeller Foundation Center in Bellagio, Italy.

ACADEMIC PROGRAM AND STUDENT ENROLLMENT

During the past year, 943 students enrolled in Literature subjects, 17 were registered as Literature majors (including 5 students with a major departure in CMS), 17 as minors with an additional 5 students minoring in CMS, and 90 as concentrators in Literature, with 25 additional students minoring in CMS. The Comparative Media Studies graduate program enrolled five students in its first entering class.

The Literature Faculty developed a number of new subjects and revised several existing subjects to support the new graduate CMS curriculum, including Literature and Film 21L435/CMS 840 and Interactive Narrative 21L489/CMS 845. In the seminar tier, Problems in Cultural Interpretation 21L707/CMS 870 was offered as a CMS graduate subject taught by Professor Jenkins in collaboration with Professor Justine Cassell of the Media Laboratory (special topic Children's Culture) and Technologies of Humanism 21L708/CMS 910 (special topic Hypertext, Hypermedia and Hyperreality) was taught by Professor Peter Donaldson.

Other Literature subjects had new or revised topics for 1999–2000: Dickens and Victorian England (21L702), taught by Associate Professor James Buzard; Spenser and Milton (21L704), taught by Associate Professor Mary Fuller; Virginia Woolf and Shakespeare (21L701) taught by Associate Professor Diana Henderson; Shakespeare's Contemporaries: Money, Sex and Violence in Renaissance Drama (21L703) taught by Associate Professor Shankar Raman; Willa Cather (21L705) taught by Professor Cynthia Woolf; Medieval Short Fiction (21L460), taught by Assistant Professor James Cain; Slavery in American Literature (21L707) taught by Lecturer Wyn Kelley; and American Short Fiction (21L512) taught by Professor John Hildebidle.

RESEARCH AND PUBLICATION

Professor Donaldson published "'All which it inherit': Shakespeare, Globes and Global Media" in *Shakespeare Survey*, an article on using the Shakespeare Electronic Archive in the classroom in the MLA volume on *Teaching Shakespeare through Performance*, and is working on a book on Shakespeare in the age of global electronic communications. Professor David Thorburn became editor-in-chief of a new MIT Press book series to be called "Media in Transition," devoted to historical/cultural studies of old and new media. Professor Perry published three articles on women in eighteenth century literature in collected volumes published this year, and two of her essays, "Radical Doubt and the Liberation of Women" and "De-familiarizing the Family; Or Writing Family History from Literary Sources" were reprinted. She is completing her study of the family in the eighteenth century novel. Professor Hildebidle published *Defining Absence*, his fourth book of poems. Professor Tapscott's "Sky, A Sky, Skies, Heaven, A Heaven, The Heaven, Heavens!: Reading Szymborska Whole" was published as a lead article in the *American Poetry Review*. He also published an article on prosody in *English and American Literature*, and several articles on Szymborska in collected volumes. His anthology of Latin America Poetry went into a third edition this year. Professor Jenkins published articles in the *Technology Review*, The *College Board Review*, *Independent Schools*, and in several collected volumes: *Kids' Media Culture*, ed. Marsha Kinder; *Reinventing Film Studies*, eds. Christine Gledhill and Linda Williams; *A Companion to Film Theory*, eds. Toby Miller and Robert Stam. In addition, essays by Professor Jenkins were reprinted in *Media Studies: A Reader*, eds. Paul Marris and Sue Thornton, and *American Cultural Studies*, eds. John Hartley and Roberta Pearson. Professor Fuller completed five articles on Renaissance travel and continues work on her book *Geographies and Subjectivities*. Professor Buzard is completing his book on autoethnography in the nineteenth century, and he published articles in the *Yale Journal of*

Criticism and in *Dickens, Europe and the New Worlds,* ed. Anny Sadrin. Professor Henderson published articles in the *Encyclopedia of the Renaissance* and is completing her manuscript Uneasy Collaborations, a study of how later writers, performers and filmmakers developed collaborative relationships with the past, and especially with Shakespeare. Professor Raman's book *Framing India: The Colonial Imaginary in Early Modern Culture* is in press at Stanford University Press. Assistant Professor Christina Klein published "The Discourse of Adoption and the Cold War Commitment to Asia" in *Cold War Constructions: The Political Culture of United States Imperialism,* ed. Christian Appy, and is completing revisions of her book on the image of Asia and Asians in Cold War-era culture, to be published by the University of California Press. Professor Cain is revising his dissertation on literature and performance in Angevin England.

ELECTRONIC PROJECTS

Professor Donaldson's Shakespeare Electronic Archive was selected as one of three launch projects under the MIT-Microsoft iCampus Alliance. Under the iCampus grant, Microsoft engineers are working with Shakespeare Project staff to develop a text-video annotation system that will enable students and teachers to work collaboratively from remote locations, conducting real time discussions of Shakespeare plays and films or working asynchronously to produce multimedia essays. In addition, the Shakespeare Project has begun an alliance with the Folger Shakespeare Library Education Department and a number of high school teachers throughout the U.S. to make the Archive more useful in supporting active learning in K–12 classrooms. Professor Jenkins' NEH-funded Virtual Screening Room project, a prototype of a multimedia film textbook with 400 video examples, was completed this year. Professor Buzard serves as one of the editors of the international Monuments and Dust Electronic Archive devoted to Victorian history and culture. Professor Thorburn is editor-in-chief of the Media in Transition website.

CONFERENCES AND INVITED ADDRESSES

Professor Donaldson delivered the Catherine Caroll Tagliaferro Shakespeare Lecture at the University of Akron, addressed the National Council of Teachers of English Biennial International Conference on Teaching Shakespeare and contributed a paper to the Shakespeare Association of America's annual meeting in Montreal. Professor Alvin Kibel spoke at conferences on literature and technology and ethics at Belfort, France, and in Berlin. Professor Thorburn delivered the keynote address at a conference on "Knowledge Transfer and the Knowledge Society" in Ladenburg, Germany, sponsored by the Daimler-Benz Foundation. Professor Perry gave the Presidential Address at the annual meeting of the American Society for Eighteenth Century Studies and spoke at Northwestern University and Gettysburg College. Professor Tapscott gave the plenary address at the "Text Agonistes" conference at the University of Athens, directed the Literary Seminar at the University of Rome, gave the convocation address at the Cracow/Silesia conference on Gender Studies and Queer Theory, and spoke at the Universities of Lodz, Warsaw, Torun, Bialisock, Prague, Salzburg and Vienna. Professor Jenkins was the Chair and Keynote Speaker, Video and Computer Games Come of Age Conference, MIT, Cambridge, MA , gave the keynote address at the Camden Technology Conference in Camden, Maine, and spoke at the University of Birmingham, England, the University of North Carolina, Chapel Hill, Wayne State University, the University of Odense, Denmark, at the Console-ing Passion Conference in Chicago, at the Society for Cinema Studies in Chicago, at the Rotterdam International Film Festival, at the Kids' Screen Conference in New York, Readercon in Waltham, MA, at the Game Developers' Conference in San Jose, CA, and to various groups in San Francisco and Seattle. Professor Fuller gave a paper at the Association for Mediterranean Studies meeting in Rio de Janeiro, and spoke at the University of Kansas. Professor Buzard delivered the plenary address at an international conference on Walter Scott at the University of Oregon, and spoke at Harvard, the University of California, Santa Cruz, Salem State College and the University of London. Professor Henderson spoke at the Centenary Conference on Shakespeare on Film at the University of Malaga, Spain, chaired a panel at the annual meeting of the Renaissance Society of America in Florence, Italy, and contributed a paper at the annual meeting of the Shakespeare Association of America in Montreal. Professor Cain spoke at Harvard and Boston Universities. Professor Klein spoke at the meeting of the French Association of American Studies at Aix-en-Provence, at Harvard and the University of Connecticut, and at the annual meeting of the American Studies Association.

AWARDS, SERVICE AND GRANTS

Professor Tapscott was appointed Fulbright Distinguished Professor in American Studies at the University of Lodz, Poland. Professor Klein was awarded an Old Dominion Fellowship and a Fellowship at the Charles Warren Center for American Studies at Harvard University. Professor Perry held an appointment as Fellow at the Rockefeller Foundation Center in Bellagio, Italy. Professor Buzard was awarded the James Levitan Prize in the Humanities for his work on autoethnography in British literature.

Professor Jenkins serves as Director of Comparative Media Studies at MIT and as Housemaster for Senior House. Professor Thorburn serves as Director of the MIT Communications Forum and of the Media in Transition Project. Professor Donaldson is a member of the Executive Committee of the Shakespeare Division of MLA and serves on MIT's Council for Educational Technologies. Professor Perry served as President of the American Society for

Eighteenth Century Studies and on the Dean's Committee on Gender Equity and the CUP Subcommittee on the Communication Requirement at MIT. Professor Henderson serves as Shakespeare Division delegate to the MLA General Assembly. She also co-chairs the Shakespeare Seminar at the Center for Literary and Cultural Studies at Harvard University and served on the HASS Overview Committee, the Search Committee for the Dean of Undergraduate Education and the Dean's Committee on gender Equity at MIT. Professor Kibel serves as Seminar Director at the Aspen Institute in Aspen Colorado.

PERSONNEL

James Cain was promoted to Assistant Professor beginning in July, 1999. Shankar Raman was promoted to Associate Professor and was also appointed to the Class of 1957 Career Development Chair. Diana Henderson was promoted to tenure. William Uricchio was appointed Professor of Comparative Media Studies, beginning in July, 2000. Alex Chisholm was appointed as development officer for the Comparative Media Studies Program.

More information about the Literature section can be found on the World Wide Web at http://web.mit.edu/lit/www/.

Peter S. Donaldson

MUSIC AND THEATER ARTS

Music and Theater Arts continues to afford students at MIT the opportunity to experience the unique language and process of the arts. Faculty and teaching staff help students understand art's demand for rigor and discipline and its non-quantitative standards of excellence and beauty. A strong, comprehensive program in both Music and Theater Arts, encompassing history, theory and performance—taught by a faculty and staff of the highest caliber whose ongoing professional activities inform their teaching—has been and will continue to be our hallmark. Because it is comprehensive, the academic program continues to produce graduates who have the talent and desire to extend their education in Music or Theater beyond the undergraduate level.

HIGHLIGHTS OF THE YEAR

Professor Peter Child completed his tenure as Section Head in June of 1999. Professor Marcus Thompson and Institute Professor John Harbison were Acting Section Heads for fall and spring respectively. Professor Ellen Harris has been appointed Section Head as of July 1, 2000. Lecturer Frederick Harris began his first year as Director of Wind Ensembles. The MIT Symphony Orchestra, under the direction of Assistant Professor Dante Anzolini, performed a highly successful concert tour in May of Prague, Budapest and Vienna. Professor Harbison's Opera *Gatsby*, commissioned by the Metropolitan Opera Company, premiered in December 1999 with many members of Music and Theater Arts in attendance. Martin Luther King Scholar Guillermo Gomez-Peña worked with Theater Arts and students from across MIT to produce the performance piece *Museum of Irrelevant Races*. Music and Theater Arts and Assistant Professor Thomas DeFrantz hosted the first African American Performativity Conference. Music and Theater Arts and Lecturer Harris hosted the Herb Pomeroy 70th Birthday Celebration: Mr. Pomeroy founded the MIT Jazz Ensemble in 1963 and was director until 1985. The Herb Pomeroy Jazz Ensemble Fund has been established to support the commissioning of new works for the Jazz Ensemble. Music and Theater Arts was assigned new administrative and office space. Work has begun on the renovations for occupancy in the fall of 2000.

HONORS AND AWARDS

Professor Child received a Provost's Fund award to support recordings of his compositions for New World Records. Professor Evan Ziporyn received a Provost's Fund Award to support two recordings of his recent compositions. Associate Professor Brenda Cotto-Escalera received a Woodrow Wilson National Foundation Award to support her performance piece *Immaculate Infection: Performing AIDS at the Crossroads of Cultural Difference.* Professor DeFrantz received a Provost's Fund Award to support *Monk's Mood*, a performance project using tap dancing to interpret the music of Thelonius Monk.

PROGRAM HIGHLIGHTS

Enrollments in Music and Theater were 1131 and 357, respectively, for a total of 1499. Music and Theater Arts continued to host the MIT Chapel Series, a successful concert series featuring local solo and group performers. The MIT Guest Artist Series hosted the Miami String Quartet, winners of the Concert Artists Guild New York Competition. Mithas (MIT Heritage of the Arts of Southeast Asia), under the direction of Senior Lecturer George Ruckert hosted a performance by renowned northern Indian performer Ali Akbar Khan. Mitcan, MIT African Music and Dance Ensemble, celebrated its 4th anniversary in a concert featuring guest performer Wu Man, Chinese Pipa virtuoso, and Professor DeFrantz, choreographer.

Theater Arts hosted guest artist and internationally known choreographer Donald Byrd and members of his dance company. Professor Cotto-Escalera and Professor DeFrantz collaborated on the performance of Professor DeFrantz's *Monk's Mood.* Theater Arts has formalized an on-going collaboration with the Boston based theater company, The Theater Offensive and its Artistic Director Abe Rybeck. Professor Cotto-Escalera and Professor DeFrantz have both produced works for The Theater Offensive and Mr. Rybeck will be teaching workshops at MIT. Theater Arts hosted a reception and discussion with Edward James Olmos. Theater Arts faculty were active as directors of major student productions. Dramashop produced *Tartuffe* by Moliere directed by Visiting Artist Michael Hammond. Shakespeare Ensemble produced *Taming of the Shrew*, directed by Senior Lecturer Michael Ouellette and *A Midsummer Nights Dream* directed by Visiting Artist Lisa Wolpe. Professor DeFrantz directed *The Colored Museum* for the Black Theater Guild. Associate Provost Alan Brody directed Playwrights in Performance in two evenings of one-act plays by MIT student playwrights.

ACHIEVEMENTS

Professor Jeanne Bamberger guest lectured at the University of Illinois and was the invited speaker at Tel Aviv University for a series of lectures in December. She spoke at the National Society of Community Music Schools in Colorado and at the Music Educators National Conference in Washington D.C. Her Book *Developing Musical Intuitions: A Project-based Introduction to Making and Understanding Music* was published in the fall. Her paper *Learning from the Children We Teach* appeared in the *Bulletin of the Council for Research on Music Education.*

Professor Child completed three commissions, *Refrain* for the New England Conservatory 2000 Spring Festival, *Viola Sonata* for the Harvard Music Association and *Variations* for a private commission.

Professor Harris has completed her book on Handel's cantatas titled *Handel as Orpheus.* She also completed articles for *Händel-Jahrbuch* and *American Handel Society Newsletter.* She gave pre-concert lectures for Boston Baroque and Handel and Haydn Society and offered a series of lectures to Boston Symphony contributors.

Professor Lowell Lindgren was elected to serve on the board of the American Handel Society. His publications include articles for the *New Dictionary of National Biography, Italian Music in 18th-Century Britain, and Quaderni della Rivista Italiana di Musicologia.*

Professor Thompson performed the Boston Premiere of Professor Harbison's *Viola Concerto* with the New England Conservatory Honors Orchestra. He appeared in two concerts with the Boston Chamber Music Society performing the *Bach Brandenburg Concertos.* He was in Holland for concert tours in November and May and performed in Alaska at the Sitka Summer Music Festival for the twentieth year. He finished the year with performances at the chamber music festivals in Seattle, and Rockport, Maine and Rockport, Massachusetts.

Professor Ziporyn saw the release of his CD *Gamelan Galak Tika* on the New World label. Two of his compositions appear on the Maya Beiser CD *Kinship* on the Koch International label. He appears as a performer on Steve Reich's *New York Counterpoint/Eight Lines/Four Organs* CD on the Nonesuch label and on Tan Dun's *Symphony 2000* on Sony Classical. He performed with Bang On A Can in Holland, Warsaw, Estonia, Oslo, Paris and Athens.

Professor Anzolini guest conducted the National Symphony Orchestra of Argentina and continued as conductor and teacher at Argentina's Festival of the Arts of Itu. He completed the premiere recording of the Fifth Symphony by Philip Glass with the Vienna Radio Symphony Orchestra for the Nonesuch label.

Professor Anzolini was recently appointed Resident Conductor for the American Composers Orchestra in New York.

Professor Cotto-Escalera collaborated with The Theater Offensive to produce and direct *Immaculate Infection* and worked with students at Eggleston Community High School to create a play on Lizzie Borden and sensationalism in the media. She served on the board of Women Playwrights International.

Professor DeFrantz created and performed in the premiere of *Monk's Mood: A Performance Meditation on the Life and Work of Thelonious Monk.* As founding Artistic Director of the Boston Theater Offensive's resident acting company he directed the company's debut in March. In a week-long residency he held master classes and lectured at the University of Calgary and presented the keynote address *Ballet in Black: Vernacular Humor in American Ballet* which will also appear as a chapter in the book *Dancing Lessons: Cultural Histories of the Body* by Anne Flynn, editor.

Senior Lecturer Ed Cohen saw performances of a number of his compositions this year. The *Piano Quartet* was performed in Marblehead at the Music at Eden's Edge Festival and at Warebrook Contemporary Music Festival in Vermont. *An Otter* for men's chorus with six instruments was performed at Cornell University and *Songs of Enchantment* was presented at Collage New Music with Janice Felty, mezzo-soprano.

Senior Lecturer David Deveau performed extensively around the United States appearing in solo and collaborative recitals in San Francisco, Seattle, San Diego's Mostly Mozart Festival and Strings in the Mountains Festival in Colorado. Closer to home he has performed for the Metropolitan Museum of Art in New York, Fleet Boston Celebrity Series, and Bates College Artists Series in Maine. His orchestral appearances include the Pittsburgh

Symphony Orchestra and the New Philharmonia Orchestra. He continues as Artistic Director for the Rockport Chamber Music Festival.

Senior Lecturer Martin Marks was named Music Director for the Treasures of American Film Archives and has completed the scoring for 36 films without original soundtracks. He is currently completing a score for the 1916 film *Where Are My Children?* for Turner Classic Movies.

Senior Lecturer Ouellette wrote the entry *Music Inspired by Shakespeare* for *Shakespeare's World and Work: An Encyclopedia for Students*. He was Visiting Fellow at the Oakley Center for Research in the Humanities and Social Sciences.

Lecturer Harris was guest conductor for the New Hampshire Philharmonic Orchestra and served as adjudicator for the Massachusetts Instrumental Conductor's Association solo and ensemble festival. His article *Striving for Excellence: An Interview with Frank Battisti* was published in *The Instrumentalist*. He was selected as a participant in the Conductor Guild's Workshop conducting the New Orchestra of Boston.

Senior Lecturer Pamela Wood guest lectured at New England Conservatory of Music on African American Folksongs. She was soloist with the Aardvark Jazz Orchestra for a series of concerts and continued as conductor of the Vocal Ensemble at The Women's Inn at Pine Street.

Lecturer Mark Harvey published the article *Jazz Time and Our Time* in the collection *This Is How We Flow: Rhythm in Black Cultures*. His composition *Gabriel's Choir* was performed by the Aardvark Jazz Orchestra and recorded for a forthcoming CD titled *The Seeker*. He guest lectured for the Brown Lectures at Boston University's School of Theology on Duke Ellington's Sacred Music.

Lecturer Elena Ruehr saw performances of her commissioned works *The Law of Floating Objects* and *Song of the Silkie* with libretto by Lecturer Laura Harrington.

PERSONNEL

Assistant Professor James Makubuya accepted a position at Wabash College in Indiana and will be leaving MIT in June. David Deveau was reappointed as Senior Lecturer. Music and Theater Arts affirms its commitment to diversity within its disciplines and among its staff. Seven members of our full-time faculty and teaching staff of twenty are under-represented minorities or women.

More information about Music and Theater Arts can be found on the World Wide Web at http://mit.edu/mta/www/.

Ellen T. Harris

PROGRAM IN WRITING AND HUMANISTIC STUDIES

The Program in Writing and Humanistic Studies offers MIT students the opportunity to study the techniques, forms, and traditions of contemporary writing, including basic expository prose, the essay, fiction and poetry, journalism, professional communication, oral communication, and writing for electronic media. Program members include artists, journalists, and scholars who write fiction and poetry, write informatively about science and technology, and publish research in a variety of traditional and interdisciplinary humanistic fields. The Faculty includes joint appointments in History, History of Science and Technology, Physics, and Mechanical Engineering. Program members work in three different contexts: in the core academic curriculum, made up of HASS distribution subjects and electives; in outreach programs throughout the Institute in writing-across-the-curriculum; and in the Writing and Communication Center. Program subjects during the past year enrolled 1318 students (up from 1281 the previous year), of which 12 were majors, 33 were minors, and 109 were concentrators in writing for the HASS requirement. In addition to our standard subject offerings, our writing-across-the curriculum programs brought writing instruction to more than 1500 students in departments throughout the Schools of Science, Engineering and Architecture. Finally, our Writing and Communication Center posted a total of 706 undergraduate and graduate students (up from 612 the previous year) making 2,565 visits for help on reports, papers, oral presentations, and thesis projects.

RESEARCH AND PUBLICATIONS

Professor Alan Lightman's new novel, *The Diagnosis*, is due out in the fall of 2000 with Pantheon Press. In addition, he completed a guest editorship of Houghton Mifflin's *Best American Essays, 2000* and a new edition of his *Great Ideas in Physics* (McGraw Hill). Professor Anita Desai's *Fasting and Feasting* which appeared in June, 1999, in England (Chatto) and was shortlisted for the Booker Prize, was published in the US by Houghton Mifflin. Her collection of short stories, *Diamond Dust and Other Stories*, which is dedicated to her MIT fiction-writing students, was also published this year by Houghton Mifflin. Assistant Professor Helen Lee's novel, *Water Marked*, was published by Scribner in July, 1999, and she is currently working on a collection of short stories. Professor Robert Kanigel's biography, *The Man Who Knew Infinity*, was translated into Korean. He continues work on his history of travel and tourism, *High Season*, which is due out in the spring of 2001. Professor Kanigel's book, *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency*, served as the basis for a one-hour PBS documentary titled *Stopwatch*, on which Professor Kanigel worked as a consultant. Professor Kenneth Manning is working on a study titled *Blacks in American Medicine, 1860–1980*. For this project, Professor Manning has developed an extensive database on black physicians throughout the USA, which will eventually be available to the public. Professor Cynthia Wolff continues work on a literary biography of Willa Cather. Professor James Paradis is completing the second edition of his reference work *The MIT Guide to Science and Engineering Communication* (MIT Press). Associate Professor Susanne Klingenstein has begun research on a new book, tentatively titled *Coping with the Past: The Destruction of the European Jews in Germany's CulturalHistory*. Adjunct Professor Joe Haldeman's new novel, *Forever Free*, was published by Ace Books, as was his novella *A Separate War*. He is at work on a new novel, set in 19th century America and Alaska, titled *Listen to the Raven*. Senior Lecturer Edward Barrett has completed his reference volume *The MIT Guide to Web Design*, which has a fall publishing date with MIT Press. A collection of his poetry is due out with Zoland Books in the spring of 2001. Dr. Barrett continues work on his study, *The Poetics of Cyberspace*, which is also under contract to MIT Press. Writer-in-Residence Stephen Alter has completed his book, *Amvitsar to Lahore: A Journey Across the India-Pakistan Border*, which is scheduled to be published by the University of Pennsylvania Press in the fall of 2000. He is currently working on *Sacred Waters: A Pilgrimage to the Many Sources of the River Ganga*, which is under contract to Harcourt Brace. Writer-in-Residence Christopher Sawyer-Laucanno has completed his travel memoir on contemporary Yucatan, *Under the Mayan Sun: Incidents of Travel in Yucatan*, which is due out with Grove Press in December 2000. He has also had accepted for publication, *Words and Images: the Twentieth-Century 'Livre de Peintre' in France* by Museum of Fine Arts Books. Lecturer Rebecca Faery, Director of First-Year Writing, published her study, *Cartographies of Desire: Captivity, Race, and Sex in the Shaping of an American Nation* with the University of Oklahoma Press. She is currently working on a collection of personal essays titled *One Woman, One War: Remembering Vietnam*. Dr. Leslie Perelman is working jointly with Professor Henry Jenkins on a reader and writing handbook, *Joining the Conversation: Writing about Popular Culture* (Mayfield Press).

ACADEMIC PROGRAMS AND INITIATIVES

The Program in Writing and Humanistic Studies is supporting three major HASS initiatives at the Institute: the Communication Requirement; the Comparative Media Studies M.S. Program; and the Graduate M.S. Program in Science Writing. This past spring, the MIT Faculty voted to pass a new Communication Requirement proposed by the Committee on the Undergraduate Program. This new requirement replaces the old proficiency-based Writing Requirement with a new, instructionally-based requirement: every undergraduate must take some form of instruction

in writing and speaking each year of his or her four-year program. Writing Program faculty and staff, with the financial assistance of the Dean of HASS and the Provost, have taken several steps to reorganize the Program's resources in ways that will support the needed communication instruction. The first step has been to reorganize the expository writing sections (28 sections in PWHS, completed by 425 students last year) into a first-year expository writing program. Roughly 20 percent of incoming MIT freshmen are now required, on the basis of their performances on the Freshman Essay Evaluation (FEE) test, to take an expository writing class. Two years ago, PWHS appointed the experienced lecturer and scholar Dr. Rebecca Faery as Director of First Year Writing. She has undertaken a program of redesigning our first-year expository writing curriculum, and she has also inaugurated an extensive, year-long program of training for all of our first-year writing instructors. This program has been very successful in improving the standards, interest, and consistency of our expository writing subjects, as well as in introducing new elements of oral communication to the traditional subject matter. The second step in reorganizing PWHS elements to support the Communication Requirement has been that of revamping and expanding of our writing-across-the-curriculum (WAC) programs. The object of these decentralized programs, some of which are considerably older than PWHS itself, is to take writing instruction and evaluation into core subjects of science and engineering departments throughout the Institute. Last year, PWHS faculty brought Dr. Leslie Perelman and Ms. Madeline Brown over from the Office of the Dean of Students to the PWHS, where they assumed the respective duties of Director of Writing Across the Curriculum and Coordinator of Writing Initiatives. Perelman and Brown have considerably expanded the WAC teaching efforts of PWHS throughout every department at the Institute (except the Sloan School), and they have experimented extensively with innovative instructional efforts like the tutorial program in the Biology Department that produces student research writing in the Biology Undergraduate Journal (BUG). The third step in reorganizing for the new Communication Requirement has been the strengthening of the Writing and Communication Center. This PWHS facility, which is now nearly twenty years old, dealt with a record number of students (a 30% increase over last year). Anticipating an increased demand on the center's resources as the result of the Communication Requirement, the center's Director, Dr. Stephen Strang, experimented with several new tutoring strategies, including special practice seminars on oral communication, an online center (which had 5,838 hits in April and May), an online tutor (which accepts writing samples of up to 1000 words and worked with 80 students), and an extended hours program in the evenings and on weekends.

The second major initiative of PWHS has been its collaboration with the Foreign Languages and Literatures section and the Literature Faculty for the past two years to support the new Comparative Media Studies Graduate Program (CMS). This three-section collaboration, under the direction of Professor Henry Jenkins, has brought the sections together in a very new way. We have pooled resources, collaborated in developing an interdisciplinary graduate curriculum, shared in the advising of graduate students, and jointly governed the policy of CMS. Dr. Barrett, who teaches the writing in digital media subjects in PWHS, taught three subjects that were used by CMS students: The CMS Workshop (CMS.950), Interactive and Non-Linear Narrative (21W.765J), and Writing in Cyberspace (21W.785). In addition, the PWHS head was a member of the governing board for CMS, which met regularly throughout the year to set policy and make decisions. Faculty of PWHS will also serve on search, curriculum and other administrative committees to help run the CMS.

Our third, but by no means least important, initiative has been that of developing a new Graduate (M.S.) Program in Science Writing. Last year was a decisive one in our planning: we were able to get preliminary support for this concept from the Dean of HASS, the HASS Visiting Committee and the Provost, to whom we made formal presentations on the mission and scope of the degree program. With this new Master's program, MIT, long a leader in the education of scientists and engineers, will begin to nurture the writers, reporters, and critics who can interpret and explain science and technology to the wider public. The need for such men and women has never been greater. This initiative is building on the existing curriculum and faculty in the Program, a faculty that includes as co-directors two distinguished science writers: Professors Kanigel and Lightman. Other members of the planning committee include Boyce Rensburger (Head of the Knight Fellows Program), Professor Manning, B.D. Colen, and Professor Paradis. This past year, the organizing committee developed a program proposal, which laid out the subject descriptions, requirements, costs and implementation schedule for the program. The goal for the next year will be to present the program proposal to the School Council and possibly the Faculty, develop a detailed business plan, and develop a fund-raising apparatus. We are aiming to start the program in the fall of 2002.

SERVICE, GRANTS, AND AWARDS

Professor Desai, on sabbatical this past year, was shortlisted for the Booker Award for her *Fasting, Feasting.* Professor Lightman was named Guest Editor of McGraw-Hill's annual collection of best American essays. He was also a Convocation Speaker at Clarkson University, the keynote speaker at a Wellesley College conference on *Origins*, and a featured speaker at the Jerusalem International Book Fair. Professor Kanigel was a member of the

Advisory Committee for the Society for the History of Technology. He also spoke at the American Society of Journalists and Authors on *Trends and Techniques in Narrative Nonfiction.* His Alfred and Julia Hill Lecture at the University of Tennessee, *The Perils of Popularizing Science*, was published as a booklet by the School of Journalism at the University of Tennessee. Professor Lee's novel *Water Marked* was excerpted in *Essence* magazine. She gave many public readings from her new novel in Cambridge, Washington D.C., Detroit and Ann Arbor. She was also featured in interviews published in *Callaloo* magazine and the collection, *Black Fiction Writers on Writing* (Avon Books). Dr. Barrett co-chaired the admissions committee for the Comparative Media Studies Program, served on the CMS Steering Committee, the Institute Classroom Advisory Committee, and the Governing Board of the Communications Forum. He is also the General Editor of the MIT Press Series on Digital Communication that was cited by ACS for special distinction. Dr. Faery gave the keynote address at a writing conference at the University of Connecticut, and she was featured speaker at the Cambridge Forum. Professor Klingenstein received the Certificate of Merit from the Counsel General of Germany for distinguished literary criticism. For his 1999 novel, *Forever Peace*, which won the Hugo award last year, Professor Haldeman won the Nebula and John W. Campbell awards this year. He was also the featured speaker at several conventions, including the World Science Fiction Convention in Melbourne.

More information about the Program in Writing and Humanistic Studies can be found on the World Wide Web at http://web.mit.edu/humanistic/www/.

James G. Paradis

DEPARTMENT OF LINGUISTICS AND PHILOSOPHY

The Department of Linguistics and Philosophy is made up of two sections consisting of twenty-six faculty members (five of them jointly appointed), sixty-nine graduate students, two dozen or so visiting scientists and scholars, an administrative officer, a student administrator and six support staff members. Each section operates independently of the other; yet between them there is a significant overlap of intellectual interests in education and research, among the faculty, graduate students, and visitors. In the most recent (1995) National Research Council rating of graduate programs in the United States, Linguistics and Philosophy were ranked first and tenth, respectively, on faculty quality: and second and seventh, respectively, on program effectiveness.

The linguists continue to pursue an account of natural language in terms of principles of computation and representation. The Minimalist Program for Linguistic Theory, Optimality Theory, and the Theory of Distributed Morphology offer somewhat different yet sometimes complementary suggestions for the course that the pursuit might follow. These ideas continue to be explored, developed, and challenged in research on syntax, semantics, morphology, phonology, and on the interfaces between these modules of the grammar of natural language by MIT graduate students, faculty, and visitors.

Neurolinguistic research has been added to work on language acquisition and use and is now a central piece of linguistics research at MIT. Experimental research of all sorts has been supported by the [Mind Articulation] Project —a five year, joint MIT Linguistics/Tokyo University Physiology project funded by the Japan Science and Technology Corporation—which enters its last year in 2000–01. The Department continues to run the KIT/MIT MEG brain imaging facility, which draws researchers from other Departments and Universities.

Research in philosophy is not so neatly programmatic as it is in linguistics; thus it is best simply to list the wide range of topics pursued in current research in philosophy at MIT including but not exhausted by the following: theories of consciousness and the mind-body problem; causation and laws of nature; analysis of fundamental metaphysical concepts: substance, attribute, essence, set, identity, etc.; problems at the intersection of ethics and historical sociology; foundational questions of quantum physics; analysis of natural laws and their role within scientific theories; applied aesthetics; the foundations of "possible worlds" semantics for modal and conditional logics; the ontology of events; the identity across time of people and other physical objects; the principles of rationality governing ethical reasoning; and the role of evaluative thoughts in practical reasoning.

As in the past, the faculty on both sides of the department participated in a large number of colloquium and acted as keynote speakers at conferences and workshops in various parts of the United States and the world. A number of our faculty serve as editors and/or members of editorial boards for numerous journals both in the United States and abroad. They also published a large number of journal articles, book chapters, and reviews. In addition, a book appeared during the year by Institute Professor Noam Chomsky: New *Horizons in the Study of Language and Mind*, Cambridge, University Press, 2000. Several other books are in progress.

Professor Chomsky was awarded honorary degrees from Harvard University, University of Toronto, University of Western Ontario, and Scuola Normale, Pisa. Associate Professor Sally Haslanger received the Class of '51 Fund for Excellence in Education, Class of '55 Fund for Excellence in Teaching, and Class of '22 Fund for Educational Innovation, with Assistant Professor of History Lora Wildenthal. Associate Professor Ralph Wedgwood received the Jean Hampton Prize from the American Philosophical Association for the best paper submitted to the APA's Pacific Division meeting by an untenured philosopher.

Professor Irene Heim was on a leave without pay for the fall semester. Assistant Professor Michael Glanzberg was on Old Dominion Leave for the fall semester.

Professor Alec Marantz assumed the position as Department Head on July 1, 1999.

It is with great pleasure that we announce that Assistant Professor Norvin Richards has been selected as the next holder of the Mitsui Career Development Professorship. We would also like to announce the promotions of Edward J. Hall and Cheryl Zoll to the rank of Associate Professor without tenure.

We are still one appointment away from reaching our revised affirmative action goal of six women on the faculty and will continue our efforts to recruit qualified women and minority candidates to the faculty.

More information about this department can be found on the World Wide Web at http://web.mit.edu/philos/www/ or http://web.mit.edu/linguistics/www/.

Alec Marantz

DEPARTMENT OF POLITICAL SCIENCE

The MIT Department of Political Science offers a broad-based undergraduate curriculum in political science; provides graduate education and research training at the highest level of excellence; maintains an environment in which faculty and advanced students can carry out original and outstanding research on political behavior, processes, and institutions; and contributes to the capacity of governmental and private organizations at the local, national, or international level to deal effectively and humanely with the issues they confront. Throughout, the department aims to create a community of men and women—senior and junior scholars, students and staff—that is intellectually rich and diverse in terms of gender, race, and national origin.

Each of these goals is important, but essential to them all is to recruit, retain, and nurture an outstanding faculty, devoted both to research and teaching. We have, in the past three years, successfully recruited five outstanding new faculty (four assistant professors, one tenured associate professor), and will be conducting three searches this year.

EDUCATIONAL INITIATIVES

Washington Internship Program

MIT is uniquely positioned in American higher education to join the concerns of science and engineering with public service. The Political Science Department is helping MIT take the lead nationally in enhancing the education of technologically sophisticated undergraduates by exposing them to the practical world of politics and policymaking, while maintaining a high degree of academic rigor. Since 1994–95, we have provided a summer internship in Washington, DC for MIT undergraduates. The internship's purpose is not to enhance job skills, but to provide a more realistic look at policymaking than is possible in classroom settings. Professor Charles Stewart, who directs the program, also teaches a required subject on the contexts of policymaking. To date, sixty students have been placed in such organizations as: The White House Office of Science and Technology Policy, The U.S. Department of Energy, the Institute of Medicine's Board on Global Health, the U.S. General Accounting Office's Office of Transportation Issues, the World Bank, The Economic Policy Institute, the American Association for World Health and the U.S. House of Representatives Science Committee. The program, which allows MIT's technically-oriented students to experience how institutions vital to their later success operate, also gives the federal government and other policymakers early access to the best young scientists and engineers in America. We currently receive more than 100 applications for the 10 positions, so we are placing MIT's best and brightest in these internships.

For the past two years, Political Science and Economics have also collaborated on a joint Political Science/Economics Washington Summer Internship Program, which enables three students from economics and political science to join the Science and Technology interns in Washington, D.C.

Professor Suzanne Berger also created an MIT France Program, which will be coordinated under the MIT International Science and Technology Initiatives (MISTI), along with the MIT-Japan, MIT-China, MIT-Germany, MIT-India, and MIT-Italy Programs. Through these programs, the department has placed nearly 1000 students in international internships over the past 20 years. And Professor Nazli Choucri has presented a proposal to the department for an Internship program in International Institutions. The educational strategy includes course work, supervised field experience, research and writing and student presentations of individual internship experience and outcomes.

Public Policy Minor

Jointly with DUSP and Economics, the department recently established a new minor in public policy. The minor provides an opportunity for undergraduates to pursue policy interests in a sustained and coherent way, without taking on the burden of a second major. The core of the program is a joint DUSP-Political Science course ("Fundamentals of Public Policy") taught by Professor Stephen Meyer and David Laws. The course enrollment has been running close to 50, suggesting great promise for the program. In collaboration with the Department of Urban Studies and Planning, Assistant Professor Susan Giaimo developed and taught "Methods in Policy Analysis" as part of core curriculum for the new Public Policy Minor. And Professor Meyer developed a course on "Public Policy and Government Action" for this interdisciplinary minor.

New Subjects

Under the direction of the Undergraduate Program Committee, Professor Meyer redesigned the undergraduate Prethesis Reading Seminar and renamed it "Thesis Research Design." Political Science majors are expected to register for this

class in the spring semester of their junior year. In this class students develop their research topics, review relevant research and scholarship, frame their research questions and arguments, choose appropriate analytical methods, draft the introductory and methodology sections of their theses, and write a complete prospectus of the project. With this redesign the undergraduate theses have improved dramatically. This year the department again awarded a $1,000 prize for the "Best Political Science Undergraduate Thesis." Associate Professor Daniel Kryder designed a new undergraduate class, 17.197, "Introduction to Political Analysis," which presents a survey of the field of political science for undergraduates. He invites faculty members in different areas of the field to present their research to the class.

Both courses are part of a broader review of the undergraduate curriculum, the aim of which is to provide greater coherence to the major and minor, and more direction for students interested in taking courses in the department.

Other new subjects developed this past year on both the graduate and undergraduate level include: Professor Stephen Ansolabehere and Assistant Professor Chappell Lawson on "Media Politics" (to be offered in 2001-2002); Lecturer Margaret Burnham on "Political Trials" (Spring 2001); Assistant Professor Brandice Canes-Wrone's "Introduction to Game Theory and Political Theory;" and Associate Professor Thomas Christensen's three new courses on "International Relations of East Asia," "Chinese Foreign Policy," and "International Strategy."

Associate Professor Kenneth Oye will offer his new course "Science, Technology and Public Policy" this coming Fall term. Professor Canes-Wrone introduced a new graduate class, "Methods of Policy Analysis," this academic year. Professor Lawson offered two new graduate classes, "Latin American Politics" and "Regime Change." Assistant Professor Jonathan Rodden introduced two new classes, an undergraduate class "Politics, Economics and Democracy," and a graduate class, "The Political Economy of Institutions." He plans to offer two new courses in Fall 2000, "Federalism and Decentralization," and with Professor Lawson, the new undergraduate introductory course "Introduction to Comparative Politics."

Miscellaneous

Professor Stewart is participating in the Residence Based Advising pilot project at McCormick Hall, for the class of 2004.

Professor Joshua Cohen is experimenting with strategies for making his Justice course a large-enrollment, communication-intensive subject—to see how to combine intensive writing instruction with a large-enrollment course.

Graduate Teaching

At the graduate level, Professor Berger and Associate Professor Richard Locke created a new dissertation workshop on comparative political economy and comparative politics. Professor James Snyder, jointly with Harvard University, co-organized the bi-weekly seminar on positive political economy. Professor Rodden is planning a workshop on "Fiscal Federalism in the European Union," which will be held at the Center for European Studies, Harvard University on November 4, 2000. Participants will include political scientists and economists from several countries.

STUDENT RECRUITMENT, ENROLLMENT, AND PLACEMENT

The department continues to compete successfully with other major departments in the recruitment of graduate students. We attracted an excellent class of incoming Ph.D. students, including six of the top ten students we admitted. Of the 16 students who accepted our offer of admission, four are female, and three are international students. The department will also enroll five Masters students in September 2000. The success this year and last seems to reflect a combination of more aggressive efforts at recruitment and the more attractuive financial packages made possible by support from ther Provost.

Our graduating doctoral students found research and teaching positions at leading universities and institutions such as Harvard University, University of Pennsylvania, University of California, Berkeley, Rutgers University, University of Wisconsin, London School of Economics, the International Labor Organization, Max Planck Institute in Germany, Tulane University, Univeristy of Copenhagen, University of Florida, and American University in Washington, D.C.

Undergraduate enrollments increased slightly: 808 in 1999–00, compared to 777 in 1998–99, while the number of undergraduate majors dropped from 35 to 27. There were 21 minors (Classes of 2000, 2001 and 2002), and 75 concentrators from the Class of 2000. Graduate student enrollment for 1999–00 was 109.

FACULTY

Kanchan Chandra, who held a prestigious American Academy Fellowship at Harvard, will join the department this year, and will be teaching in the field of ethnicity and ethnic conflict.

Assistant Professor David Woodruff has been promoted to untenured Associate Professor, effective July 1, 2000.

Increasing the presence of minorities and women in the department remains a major concern. Both search committees this past year made special efforts to identify outstanding women and minority candidates. The department received and reviewed a total of 236 applications for two open positions. Of those, 54 were women and 4 were minorities.

Search committees in the areas of International Political Economy, Chinese Politics, Civil Conflict have formed and will evaluate potential candidates at both the junior and senior level during the coming academic year.

We also are preparing a case to make a tenured professor offer to Professor Alan Gerber of Yale University.

Faculty research activities include:

- "The Rise of Money in American Elections" funded by the Carnegie Corporation; "One Person, One Vote and the Transformation of American Politics" (Professor Ansolabehere)
- Research on relations between the United States, PRC and Taiwan, and on the impact of alliance relationships on US-China relations (Professor Christensen)
- "Globalization Study" (Professor Berger)
- "Discriminatory Patterns in Application of Anti-Discrimination Laws" (Lecturer Burnham)
- "Collaborative Research on Measures of Electoral Heterogeneity" research proposal pending at the National Science Foundation; "Administrative Outcomes and the Conditions for Litigation: The Case of Wetlands Policy"; "The Two Presidencies in the Executive and Legislative Arenas," with William Howell and David Lewis; and "Research Note on Presidents' Veto Power over Budget Appropriations" (Professor Canes-Wrone)
- "Deliberative Democracy" (Professor Cohen)
- "Markets and Medicine: Welfare State Governance in Britain, Germany, and the United States," (Professor Giaimo)
- "20th Century American Presidents and the Turn to War" examines the relationship between progressive Democratic presidents, Wilson, FDR, Truman, and LBJ, and war; how wars have altered the progressive initiative, and how progressivism altered our wars (Professor Kryder)
- "Building the Fourth Estate: Democratization and Media Opening in Mexico," a survey research project on campaign effects during the 2000 presidential elections in Mexico City, sponsored by the National Science Foundation (Professor Lawson)
- "Environmental Protection as Public Policy—Tradeoffs, Costs and Benefits," and "Civic Environmentalism as Environmental Protection" (Professor Meyer)
- "Official Apologies and the Politics of Reconciliation in Australia, Canada, and the United States" (Associate Professor Melissa Nobles)
- "Export Financing and Trade Competition under the OECD Arrangement," on the effects of export financing on export patterns;" "Alliance for Global Sustainability," a joint project on trade and regulation with MIT, ETH, and the University of Tokyo; and the "Alliance for Global Sustainability, Joint Proposal on Clean and Efficient Utilization of Coal in China," a funded joint project with MIT, Tokyo University, ETH and Tsinghua University (Associate Professor Kenneth Oye)
- "Innovation in the French Army, 1918–1940" and "Innovation in the US Army, 1970–1980" (Professor Barry Posen)
- "Federalism, Ethnic Fragmentation, and Public Spending in the Indian States" (with Bela Prasad), "Federalism and Public Spending in the Brazilian States" (with Mansueto Almieda, David Samuels and Erik Wibbels), "Malapportionment and Public Spending: A Comparative Study" (with Professors Ansolabehere and Snyder), and "Fiscal Federalism in the European Union" (with Geoffrey Garrett and Robert Inman) (Professor Rodden)
- "Military Innovation During the Cold War," "The Evolving Structure of the Defense Industry," and "Comparative Bloodbanking" (Professor Harvey Sapolsky)

- "The Hidden Cost of Electoral Reform: Clean Elections and Voter Disengagement in the Philippines" (Associate Professor Frederick Schaffer)
- "Politics of Climate Change" and "The Political Role of Scientific Cooperation" (Professor Emeritus Eugene Skolnikoff)
- "Informational Rationales for Political Parties," is an NSF sponsored project; "Legislative Bargaining under Weighted Voting," "Television Costs and Greater Congressional Campaign Spending: Cause and Effect or Coincidence?" and "Equal Votes, Equal Money" (all three with Professor Ansolabehere and Alan Gerber); "Candidate Location in Congressional Elections (with Professors Ansolabehere and Stewart), "Referendums, Initiatives, and Legislative Partisanship" (with Jeffrey Lewis), "Party Platform Choice in Single-Member-District and Party-List Systems" (with Professor Ansolabehere) and "PAC Contributions and Expenditures" (with Professor Ansolabehere and Mickey Tripathi), "Why Did a Majority of Californians Vote to Limit Their Own Power?" (with Professor Ansolabehere and Jonathan Woon), "The Value of Free Media to Political Parties" (with Rachael Cobb), and "The Incumbency Advantage in Gubernatorial Elections" (with Professor Ansolabehere and Wenkai He) (Professor Snyder)
- "Parties in Congress" (with Professors Ansolabehere and Snyder), "Speakership Contests in the Antebellum House" and "History of Congressional Committees" (Professor Stewart)
- "Causes of War: Misperception and the Roots of Conflict" (Professor Stephen Van Evera)
- "Exchange Rate Politics in Russia," also research on political implications of changing organization of international investments in less developed countries, and research on the politics of gold standard adoption (late 19th and early 20th centuries) in less developed countries (Professor Woodruff)

Political Science faculty continue to be prolific publishers of books and articles.

Professor Nobles' book *Shades of Citizenship: Race and the Census in Modern Politics* has just appeared from Stanford University Press.

Professor Ansolabehere contributed "Soft Money, Hard Money, Strong Parties" forthcoming in *Columbia Law Review* (with Professor Snyder); "The Effects of Party Pressure on Congressional Roll Call Votes" in *Legislative Studies Quarterly* and "Old Voters, New Voters: Using Redistricting to Estimate the Incumbency Advantage" in *American Journal of Political Science* (both with Professors Snyder and Stewart); "Do Warchests Deter Entry?" forthcoming in *Business and Politics* and "Valence Politics and Equilibrium in Spatial Election Models" in *Public Choice* (both with Professor Snyder); and he contributed the chapters "Political Advertising" and Issue Constraint" in Neil Smelser, editor, International Encyclopaedia of Social and Behavioral Sciences, Elsevier 2000.

Professor Berger's article "Globalization and Politics" appeared in the Annual Review of Political Science. Professor Emeritus Lincoln Bloomfield contributed "The Genetically Engineered Secretary of State" in Foreign Service Journal, and his manuscript *Snapshots from the Fringe: Accidental Encounters with History* is scheduled for publication later this year. Lecturer Burnham contributed the chapter "Twice Victimized" in J. Cohen and J. Rogers, eds., *Urgent Times: Policing and Rights in Inner-City Communities*, Beacon Press 1999, and the chapter "Legal Services in Massachusetts" in R. Kass, ed., *Legal Chowder* (forthcoming). Professor Canes-Wrone contributed the chapter "Differences in Legislative Voting between Winning and Losing and Incumbents," to the Brady, Cogan and Fiorinia, eds., book *Continuity and Change in Congressional Elections,* Stanford University Press, 2000.

Professor Christensen wrote "Correspondence: Spiral, Security, and Stability in East Asia" for the Spring 2000 issue of the journal *International Security*. He also contributed "Theater Missile Defense and Taiwan's Security" to the Winter 2000 issue of the journal *Orbis*.

Professor Cohen has continued to serve as Editor-in-Chief of *Boston Review*, and in that connection edited the *Boston Review*/Beacon Press New Democracy Forum series, which produced eight books this past year; he also published several papers on democratic theory.

Professor Giaimo wrote "Adapting the Welfare State: The Case of Health Care Reform in Britain, Germany, and the United States," in the journal *Comparative Political Studies*, and contributed the chapter "New Labour and the Uncertain Futures of Progressive Politics" in Stuart White, ed., *New Labour: The Progressive Future?*, forthcoming this year from Macmillan. She also wrote the chapter "Who Pays for Health Care Reform?" in Pierson, ed., *The New Politics of the Welfare State*, forthcoming from Oxford University Press.

Professor Kryder's book *Divided Arsenal: Race and the American State During World War II* was published this spring by Cambridge University Press. Professor Lawson wrote "Democratization and Authoritarian Enclaves in Mexico," forthcoming in *Mexican Studies* this summer; his article "Building Mexico's Fourth Estate" appeared in the Spring 2000 issue of the journal *Hemisphere*. Professor Meyer contributed the chapter "Community Politics and Endangered Species Protection" in Shogren, et. al., eds, *Protecting Endangered Species in the United States*, forthcoming this year from Cambridge University Press.

Professor Oye's co-authored article "Coal Utilization in Industrial Boilers in China—A Prospect for Mitigating CO2 Emissions appeared this year in *Journal of Applied Energy*; his article "Regulatory Diversity and Trade: Can the World Trading Systems Cope?" is forthcoming this fall in the *Swiss Political Science Review*. Professor Posen wrote the chapter "U.S. Security Policy in a Nuclear-Armed World, or What if Iraq had Nuclear Weapons?" which is forthcoming in *The Coming Crisis: Nuclear Proliferation, U.S. Interests, and World Order*, Victor Utgoff, ed. (MIT Press); his article "The War for Kosovo: Serbia's Politial-Military Strategy" appeared in the Spring 2000 issue of the journal *International Security*.

Professor Emeritus Lucian Pye wrote the chapter "Democracy and Its Enemies" in Hollifield and Jillson, eds., *Pathways to Democracy: The Political Economy of Democratic Transitions* (Routledge, 2000) and the chapter "After the Collapse of Communism: The Challenge of Chinese Nationalism and Pragmatism" in Sandschneider, ed., *The Study of Modern China* (London: Hurst & Co., 1999). His obituary for the late Professor Myron Weiner was published in the September 1999 issue of *PS Political Science and Politics*. Professor Pye also wrote the article "The Thin Line Between Loyalty and Treachery in Mao's China," which is forthcoming this July in *The China Journal*. His article "Traumatized Political Cultures: The Aftereffects of Totalitarianism in China and Russia" will appear in the inaugural issue of *The Japanese Journal of Political Science* in September 2000.

Professor Rodden wrote "Decentralization and Hard Budget Constraints," for the Winter 2000 issue of *APSA-CP*, a newsletter of the Organized Section in Comparative Politics, American Political Science Association.

Professor Sapolsky wrote the article "The Defense Monopoly" in the journal *Regulation*, and "Restructuring the Defense Industry" for *International Security* (both co-authored with Eugene Gholz). Professor Schaffer's "The Study of Politics Across Cultures" will appear in *Espaces Temps*, later this year. Professor Skolnikoff's article "The Role of Science in Policy: The Climate Change Debate in the U.S." was reprinted in the Spring 2000 issue of *Journal of Liberal Arts*, a Journal on Interdisciplinary Studies of the American College of Thessaloniki, Greece, and in *Review Futuribles*, Paris, France, forthcoming this summer.

Professor Snyder's article "An Inflation Index for ADA Scores" (with Tim Groseclose and Steven Levitt) appeared in the March 1999 issue of *American Political Science Review*, and his article "Old Voters, New Voters, and the Personal Vote: Using Redistricting to Estimate the Incumbency Advantage" (with Professors Ansolabehere and Stewart) was in the January 2000 issue of *American Journal of Political Science*. His article "Majority Rule and the Under-Provision of Public Investment" (with William LeBlanc and Mickey Tripathi) appeared in the January 2000 issue of the *Journal of Public Economics*; and "Valence Politics and Equilibrium in Spatial Election Models" (with Professor Ansolabehere) appeared this summer in *Public Choice*. His article "Vote Buying, Supermajorities, and Flooded Coalitions" is forthcoming in the *American Political Science Review*.

Professor Van Evera published his book *Causes of War: Power and the Roots of Conflict* (Cornell University Press). He also served on the editorial boards of the journals *International Security*, *Security Studies*, *Journal of Cold War History*, and *Orbis*. Professor Woodruff's article "Rules for Followers: Games, Institutional Theory, and the New Politics of Economic Backwardness in Russia," is forthcoming in *Politics and Society*.

The department's faculty continue to give many invited lectures, appear at conferences, serve on boards of professional organizations and editorial boards, in addition to serving as advisors for government, private, and international organizations and agencies. Professor Ansolabehere, with Professors Skolnikoff and Canizares, organizes the Senior Congressional Staff Seminar. Professor Ansolabehere also received a Carnegie Corporation Fellowship, and the Weaver Award for the best paper on Representation at the Annual Meeting of the American Political Science Association. Professor Berger directs the MIT International Science and Technology Initiatives. Lecturer Burnham received the honorary Doctor of Humane Letters from Western New England College. Professor Choucri's research group has obtained the first patent in the history of MIT from the School of Humanities and

Social Science; the patent is for an invention of process and product in the domain of internet-based distributed knowledge networking through multidimensional representation of conceptual meanings. Professor Cohen was the Carlyle Professor at Oxford University, and also lectured at Yale Law School, McGill University, Brown, Torcuato di Tella University (Buenos Aires). Professor Nobles has been named a Research Fellow at Boston University's Institute on Race and Social Divison. Professor Posen was an invited commentator on the crisis in Kosovo for the WBUR Boston radio programs "The Connection."

Professor Richard Samuels has been a Visiting Fellow at the University of Bologna, Italy, Fall 1999; and held a Visiting Professorship at the University of Tokyo, Spring 2000. Professor Schaffer is the recipient of a grant from the Fulbright Scholars Program. Professor Snyder received the Weaver Award for the best paper on political representation at the American Political Science Association's annual meeting.

Sadly, Professor Myron Weiner, one of the most distinguished political scientists of his generation, passed away. The department held a Memorial Service in his memory in the fall.

More information about this department can be found on the World Wide Web at http://web.mit.edu/polisci/www/.

Joshua Cohen

COMPARATIVE MEDIA STUDIES

Established as a graduate program in 1999–2000, Comparative Media Studies aims to integrate the study of contemporary media (film, television, digital systems) with a broad historical understanding of older forms of human expression. The program embraces theoretical and interpretive principles drawn from the central humanistic disciplines of literary study, history, anthropology, art history and film studies, and aims as well for a comparative synthesis that is responsive to the distinctive emerging media culture of the 21st century. Students in the program are taught to explore the complexity of our media environment by learning to think across media and to see beyond the boundaries imposed by older medium-specific approaches to the study of audio- visual and literary forms.

The comparative and cross-disciplinary nature of both the graduate and undergraduate programs is embodied in a faculty drawn from Art and Architecture, Anthropology, Foreign Languages and Literatures, History, Literature, Music and Theater Arts, Philosophy, Writing and Humanistic Studies, Science Technology and Society, Media Arts and Sciences, Political Science. Approximately 35 faculty members teach subjects in Comparative Media Studies.

The graduate program comprises a two-year course of study leading to a Master of Science degree. The program aims to prepare students for careers in fields such as journalism, teaching and research, government or public service, museum work, information science, corporate consulting, media industry marketing and management, and educational technology.

RESEARCH
Five encompassing themes are at the center of the CMS program. These themes cross academic disciplines and involve both traditional and emerging communications media, establishing a focus for public presentations, research agendas, and curricular initiatives. The four primary research themes are Interactivity/Narrative/Hypertextuality; Childhood and Adolescence in a Mediated Culture; the Informed Citizen and the Culture of Democracy; Global Culture and Media; and Media in Transition.

GOVERNANCE
Professor Henry Jenkins is the Director of Comparative Media Studies. The program is under the auspices of three Humanities sections—Literature, Writing and Humanistic Studies, and Foreign Languages and Literatures. Administratively, CMS is housed in the Literature Section.

The program is governed by a Steering Committee, chaired by Professor Jenkins, which also includes Professor Peter S. Donaldson, Head of Literature; Professor Isabelle de Courtivron, Head of Foreign Languages and Literatures; Professor James Paradis, Head of Writing and Humanistic Studies; Professor of Literature David Thorburn; Professor of French and Film Studies Edward B. Turk; and Senior Lecturer in Music and Theater Arts Martin Marks.

During 1999–2000, Comparative Media Studies had five active committees, besides the steering committee: the Tenure Committee, chaired by Professor Jenkins; the Curriculum Committee, co-chaired by Professor Thorburn and Senior Lecturer Marks; the Admissions Committee, co-chaired by Professor Jenkins and Senior Lecturer Edward Barrett; the Technology and Space Committee, co-chaired by Professor Donaldson and Professor Shigeru Miyagawa; and the Orientation Committee, chaired by Professor Diana Henderson.

FACULTY HIRE
For its first hire, the Dean for Humanities, Arts, and Social Sciences authorized a Faculty search on the senior level. All efforts were made to recruit minority and women candidates through targeted advertising. After reviewing over 120 candidates, the CMS Search Committee unanimously agreed to offer the position to William Uricchio, who is Professor and Chairperson, film and television studies, new media and digital culture, at the Utrecht University, Utrecht, Netherlands. CMS conducted a tenure case, and Uricchio's appointment as Professor of Comparative Media Studies was approved this academic year and will be effective Fall 2000.

ADMISSIONS
We admitted our first five students in Fall 1999. For Fall 2000, the Admissions Committee selected ten students. Nine of the students admitted are women, and four are international students, from Norway, Canada, England, and the People's Republic of China. All ten students accepted offers of admission, but two chose to defer admission until Fall 2001, for personal reasons.

The program hosted a series of Information Sessions for potential students, which enabled them to meet the faculty and students, and better gauge the opportunities available to them in the CMS program.

FUNDRAISING

Professor Jenkins traveled extensively during the year to introduce CMS to key contacts and donors in northern and southern California, the Pacific Northwest, and New York Metropolitan Area. Our development trips yielded gifts from corporate and individual donors for research initiatives and curricular development, and equipment; an endowed chair—The Greg Shaw (1975) Fund to support a Technologist-in-Residence; and Research and Workshop Projects for our faculty and students, such as the Electronic Arts Workshops in Character and Narrative. The focus of development for this year will be the identification of sponsorship for research projects, graduate support, and education programs.

UNDERGRADUATE EDUCATION

The undergraduate program—established in 1982 under its former name, Film and Media Studies—can serve as preparation for advanced study in a range of scholarly and professional disciplines and also for careers in media or industry. The curriculum consists of some forty subjects arranged in three tiers and broadly subdivided into three areas or fields: comparative media, film, and digital studies. Concentrators, minors, joint-majors and majors may specialize in one of these areas or map a coherent combination of subjects across these borders.

CMS is also developing educational and research programs to provide additional opportunities for undergraduates to gain both academic and professional experience in media-related fields. In January, CMS coordinated a weeklong IAP event, "Adapting Linear Storytelling in an Interactive Age," with Sony Pictures Imageworks. Two undergraduates received internships at Sony Pictures Imageworks and Electronic Arts during the summer 2000. The Electronic Arts Workshop will involve one UROP for the coming year. UROP students have also played and will continue to be involved in conferences hosted by CMS and the Communcations Forum.

Current undergraduate student enrollments for the academic years 2000–2003 stand at five majors, five minors, and 25 concentrators.

The undergraduate homepage is found at http://web.mit.edu/21fms/www/.

COMMUNICATIONS FORUM

In 1999 the MIT Communications Forum relocated from the Center for Technology, Policy and Industrial Development in the School of Engineering to the School of Humanities and Social Science where it became the conference and outreach component of the CMS program. Directed by Professor Thorburn, the Communications Forum sponsors lectures, panel discussions and conferences on all aspects of communications.

LECTURES, OUTREACH

CMS sponsored weekly colloquia designed to give our graduate students, and the academic community at MIT, a rich and challenging intellectual experience, and opportunities to interact educationally and socially. Topics included: "Barbie and Popular Culture," by Erica Rand; "Photography and Childhood Innocence" by Anne Higonnet; and "German Experiments in Digital Literature," by Roberto Simanowski.

The Communications Forum sponsored several panel discussions that attracted a large audience from the academic community at MIT and in the Boston area. Topics included: "The Digital Library,""The Science in Science Fiction," and "Youth in a Digital Era." The Communications Forum also sponsored a series of readings by science fiction authors, including Nalo Hopkinson and Ben Bova.

In addition, Professor Jenkins visited a dozen high schools throughout the country between March and May, engaging students and teachers in discussions about popular culture and media convergence. These presentations were intended to inform and enlarge discussions about media literacy and the relationships youth develop with media during sustained coverage and concern following the tragedy at Columbine High School in April 1999. Roughly 1,500 students and teachers participated in these presentations in schools in Massachusetts, Maine, and New Hampshire.

Professor Jenkins also spoke at a wide variety of professional and public conferences and forums, including the Kidscreen Media Conference (New York, New York), Free Speech Network (Washington, D.C.), Camden Technology Conference (Camden, Maine), Freedom Forum (Washington, D.C.), Game Developers Conference (San

Jose, California), MIT On The Road (Seattle, Washington), American Library Association's National Conference (Chicago, Illinois), and SIGGRAPH (New Orleans, Louisiana).

In January, CMS graduate students spent a week visiting media companies and professionals in Los Angeles and San Francisco; students were introduced to television and film writers, Internet entrepreneurs, and entertainment theorists and researchers at such companies as Disney Imagineering, Warner Brothers, Sony Pictures, FirstLook, and Cheskin Research.

CONFERENCES

CMS sponsored two major conferences in 1999–2000. In October 1999 we hosted the Media in Transition Conference. This event, which was the culmination of a three-year grant by the Markle Foundation and served as the official launch of CMS, focused on the role media have played throughout history and created a forum for discussion among 250 scholars in the humanities and social sciences about the past, present, and future uses of media. Organized by Professors Thorburn and Jenkins, this international conference featured more than 60 speakers at 45 presentations, panels, and screenings. Many of the papers from the conference have been published on the Media in Transition web page: http://media-in-transition.mit.edu/.

In February 2000, MIT hosted a second conference: Computer and Video Games Come of Age. Co-sponsored by MIT and Interactive Digital Software Association, and organized by Professor Jenkins, the conference focused on the first 25 years of the computer and video games industry and explored vocabularies that game developers, publishers, professionals, and scholars could use as the industry continues to mature and emerge as an art form. The two-day event featured 20 speakers who spoke on a variety of panels that critically discussed the state of the industry and art. More than 350 people attended the event; attendees came from a variety of backgrounds, including the games industry, software development firms, scholars, and students from high school to the graduate level.

CMS also began planning activities for four major conferences in 2000–2001: Digital Cinema (November 2000); Wiring the Classroom II (November 2000); and Race in Digital Spaces, which is being co-organized by the University of Southern California (April 2001); and Television in the Post-network Era (Spring 2001).

FACULTY NOTES

Numerous faculty members affiliated with Comparative Media Studies published books this year. These include: Associate Professor Jeff Ravel, *The Contested Parterre: Public Theater and French Political Culture, 1680-1791*, Cornell University; Professor Michael Fischer and George E. Marcus, *Anthropology as Cultural Critique*, second edition, University of Chicago Press; Professor Edward B. Turk, *Hollywood Diva: A Biography of Jeanette McDonald*, paperback edition, University of California Press; Gilberte Furstenberg *Dans un Quartier de Paris*, an interactive documentary on CD-ROM, Yale University Press; Dean William Mitchell *E-topia: Urban Life Jim – But Not As We Know It*, MIT Press; Professor Irving Singer, *George Santayana: Literary Philosopher*, Yale University Press.

Forthcoming works include the Media in Transition Series, published by MIT Press. These books will publish works by humanists and social scientist who wish to speak not only across academic disciplines but also to policy makers, to media and corporate practitioners, and most of all, to their fellow citizens. Professor Thorburn is editor in chief; and Henry Jenkins and Edward Barrett are associate editors.

ADMINISTRATION

Sally Richter was hired as Senior Editorial Assistant and Douglas Purdy was hired as Senior Office Assistant. The program is currently in the process of hiring a part-time Administrative Assistant to manage Communications Forum events and conference publicity.

For more information on the Undergraduate and Graduate programs in Comparative Media Studies, contact the CMS Office, 14N-430, MIT, Cambridge MA 02139; telephone 617-253-3599; fax 617-258-5133; e-mail cms@mit.edu. The Comparative Media Studies' website is found at http://web.mit.edu/cms/.

Henry Jenkins

PROGRAM IN SCIENCE, TECHNOLOGY, AND SOCIETY

The 1999–2000 year was a good year for STS. The Program graduated four new Ph.D.s., promoted two faculty members (one to associate professor with tenure; the other to associate professor without tenure), and successfully completed a search for a junior faculty appointment. Assistant Professor David Kaiser will join our faculty on July 1, 2000. Another piece of good news is that Dean for Undergraduate Education and Robert M. Metcalfe Professor of Writing Rosalind H. Williams will be joining the STS faculty as of July 1, 2000, and will become Director of the STS Program July 1, 2002. The public STS colloquia series was again excellent, including the annual Arthur Miller Lecture on Science and Ethics delivered by Dr. Paul Farmer of the Harvard Medical School and Partners in Health. On the administrative side, we conducted a search and hired a new Administrative Officer, Ms. Christine Bates.

DOCTORAL PROGRAM

In its twelfth year, the History and Social Study of Science and Technology (HSSST) Doctoral Program (a collaborative venture of STS, the History Faculty, and the Anthropology Program) continued to develop in a satisfactory way. We are particularly pleased that four HSSST students completed their Ph.D.s. Dr. Patricia Bentley will continue as a vice president at Sapient Corporation (currently opening the Sydney Australia office); Dr. Karin Ellison will be teaching this year at the University of Minnesota; Dr. Christopher Kelty will continue his research on international developments in virtual surgery; Dr. Hannah Landecker will continue her fellowship at the Max Planck Institute in Berlin. HSSST doctoral students Mr. Brendan Foley and Ms. Rachel Prentice passed their General Exams. Present and incoming students received a variety of grants and fellowships, including fellowships from the Dibner Institute, National Science Foundation (NSF), and the Max Planck Institute, as well as Walter Rosenblith and MIT Presidential fellowships.

The HSSST Doctoral Program received 65 applications for the 2000–2001 academic year. Four students accepted, all of our top choices. Mr. Alexander (Sandy) Brown is an international student from the University of Otago, New Zealand, where he received his B.A. in History in 1998; since graduating, he has been a research fellow in the Department of History at Otago working on a social history project. Mr. Nathan Greenslit received his B.A. from St. John College in the History of Math and Science, and has been at Johns Hopkins University for the last two years in the brain and cognitive science doctoral program. Ms. Jennifer Smith received her B.A. from Macalaster College in Biology and French; she spent last year teaching English in southern France. Ms. Livia Wick received her B.A. from Brown University in Human Biology; she expects a Masters degree summer of 2000 in Arabic History and Literature from University of Paris IV, Sorbonne; currently continuing her research on Middle Eastern medical systems.

HSSST graduate students Mr. Wen Hua Kuo, Ms. Prentice, and Ms. Aslihan Sanal, were the STS representatives to the joint Harvard-MIT Culture and Science Seminar series at the Harvard Center for Literary and Cultural Studies. Professor Michael Fischer and Assistant Professor Joseph Dumit were the faculty coordinators from MIT. HSSST graduate students Mr. Kuo, Ms. Prentice, and Mr. Kaushik Sunder Rajan served on a panel at the European History and Social Studies Conference in Amsterdam in April. HSSST graduate student Mr. Benjamin Pinney had a paper selected for an international Product Management Institute (PMI) research conference, for which he was awarded a Kelly Douglas Fund travel grant to attend the conference. Mr. Pinney also learned this spring that he received a fellowship for 2000–2001 through the MIT Industrial Performance Center. HSSST graduate student Mr. Heinrich Schwarz learned that he had been awarded a Lemelson Center Fellowship at the Smithsonian Institution for Summer 2000.

PROJECTS, GRANTS, AND INITIATIVES

Professor Louis L. Bucciarelli continues to work under a grant of $47,485 from France-Telecom to carry out a comparative study of the development and use of applications related to Telemedicine in France and in the United States. He was assisted on this project by HSSST doctoral student Mr. Kelty until February when Mr. Kelty finished his doctoral studies.

Associate Professor Evelynn Hammonds received an NSF grant to write an essay on the state of historical scholarship on race in science, medicine and technology. She also received grants from the Ford Foundation and the Andrew W. Mellon Foundation ($750,000) to establish the MIT Center for the Study of Diversity in Science, Technology, and Medicine in the United States.

Professor Kenneth Keniston continued his research on cultural aspects of software localization with support from the NEC Corporation (via the Provost's MIT Research Support Committee), the Provost's HASS Fund, and the Mustard

Seed Foundation. In addition, he received a grant of $50,000 from the Ford Foundation to organize a working group on "Equity, Diversity, and Information Technology."

Assistant Professor David Mindell continued his research on technology, archaeology and the deep sea with support from the Wade Fund (via the Provost's MIT Research Support Committee), the Kaplan Foundation, and the National Science Foundation (NSF).

The history textbook project, "Integrating the American Past: A New Narrative History of the United States," with funding from the Alfred P. Sloan Foundation (grant total: $1.754 million over eight years) is in its final year. The project is headed by Professor Merritt Roe Smith and includes Professors Pauline Maier (MIT), Daniel Kevles (California Institute of Technology), and Alex Keyssar (Duke University) as primary authors. Publication is expected in the fall of 2001 and will consist of an electronic version as well as a print version of the text.

Professor Sherry Turkle received $100,000 from MIT's Committee Research Funds to conduct research on Relational Artifacts.

EDUCATIONAL ACTIVITIES

The STS Program offered 27 undergraduate subjects and 19 graduate subjects. Undergraduate enrollment totaled 428 (fall: 165; spring 263). Graduate enrollment totaled 140 (fall: 80; spring 60). There were three undergraduate majors, two minors, and 28 concentrators.

New undergraduate classes for 1999–2000 included STS.032/21H.101, "American History to 1865," taught by Professors Maier and Smith; STS.037/STS.427, "Food and Power in the Twentieth Century," taught by Associate Professor Deborah K. Fitzgerald; STS.046/SP.482, "The Science of Race, Sex, and Gender in the US," taught by Professor Hammonds; STS.049, "African Americans in Science, Technology, and Medicine," and STS.087, "Biography in Science," both taught by Thomas Meloy Professor of Rhetoric and History of Science Kenneth R. Manning. New graduate offerings included STS.457, "The Concept of 'Race' in Science, Medicine, and Anthropology," taught by Professor Hammonds; STS.467, "Research Seminar in Deep Sea Archaeology," taught by Professor Mindell; and STS.023/SP.706, "Historic Experimentation," taught by Professors Bucciarelli and Jed Buchwald (which receives LAB credit).

Professors Fitzgerald, Hammonds, and Mindell submitted a proposal to offer a new freshman class called "Factories and Laboratories" as part of a competition sponsored by the D'Arbeloff Teaching Initiative. Out of some 40 entries, theirs was one of three that were selected to do a pilot class, scheduled to be offered next spring.

SPECIAL EVENTS

This year's Siegel Prize for the best work by an MIT student in science, technology, and society was awarded to HSSST graduate student Mr. Heinrich Schwarz. Mr. Schwarz's paper, "Hidden Work in Virtual Work," was selected from a field of 18 submissions from a number of MIT departments. Serving on the Siegel Prize Committee for this year's competition were Professor Manning (chair), Professors Louis L. Bucciarelli, Jr., and Associate Professor Hugh Gusterson.

Dr. Farmer was this year's speaker at the Annual Arthur Miller Lecture on Science and Ethics held May 8, 2000. Dr. Farmer's talk, "Pathologies of Power: Science, Technology, and the Future of Human Rights" was widely attended.

The family of the late Professor Elting Morison (a founder of the STS Program and a member of the MIT faculty for 35 years) and the Hitchiner Manufacturing Company have given MIT a $500,000 endowment to establish the Morison Lecture and Prize in Science, Technology, and Society. The prize will be given each year to an outstanding individual who embodies the Morison family ideal of combining humanistic values with effectiveness in the world of practical affairs, and in particular, in science and technology. The first award went to Distinguished Visiting Professor of History of Technology Professor Thomas P. Hughes. His lecture, "A Usable History for Engineers," was held April 25, 2000.

HSSST doctoral students Mr. Shane Hamilton and Mr. Sunder Rajan helped graduate students from the STS programs at Cornell, Rensselaer (RPI), and MIT organize an informal conference this spring to improve scholarly and social communications among the major STS programs in the New England region. Hosted by MIT, the conference lasted two days. The first night, Cornell and RPI students met informally with MIT faculty members. The following day, 12 Cornell students, 10 MIT students, and 10 RPI students made brief presentations about their

current and their general research interests. Topics discussed ranged from "Street Movements: Design and Change in Urban Transport" to "Codes, Identities and Pathologies in the Construction of Tamoxifen for Breast Cancer Risk Reduction" to "Movin' All the Clocks Around: Daylight Saving and the Politics of Rural Identity." Despite (or because of) the broad range of topics, students engaged in healthy and encouraging discussions about methodologies and the state of the field. Faculty were intentionally "uninvited" to the presentations, to encourage a sense of tension-free informality. Both the presentations and the social gathering later that night created a sense of amity and scholarly unity among the students. The students are currently working on creating a permanent infrastructure for this event, with each school hosting it once every three years.

The STS Program sponsored an informal dinner on September 30, 2000, to bring together and promote collegiality between HSSST faculty and graduate students at MIT with faculty and graduate students in Harvard's History of Science Department. Because of the positive feedback, it is hoped that this will become an annual event. Harvard's History of Science Department will host the event in the coming academic year.

The STS Program held its first Spring Gala. This was an opportunity to celebrate the many accomplishments of faculty, graduate students, and staff. In addition to celebrating the faculty promotions of Associate Professor with Tenure Hugh Gusterson and Associate Professor without Tenure David Mindell, we acknowledged support staff Sophie Wadsworth for receiving a month long residency fellowship at the Virginia Center for the Creative Arts in Sweet Briar (February 2000); a Massachusetts Cultural Council Professional Development Grant ($400) ; and a Concord Cultural Council Grant ($250). Ms. Wadsworth also had a sonnet sequence published in the Winter 2000 issue of The Malahat Review (University of Victoria, BC) and gave a poetry reading in April at the Concord Free Public Library.

We also noted that Visiting Scholar Victor McElheny (formerly Director of the Knight Science Journalism Fellowships until 1998) has begun research and writing of his study, James Watson and the DNA Revolution, for Perseus Books of Cambridge. Work on the Watson project will be supported by a grant Mr. McElheny received from the Alfred P. Sloan Foundation. Other faculty accomplishments are listed individually under Faculty Activities.

COLLOQUIA SERIES AND SPECIAL LECTURES

STS Colloquia series, headed by Professor Dumit and Leo Marx Career Development Assistant Professor of History and Culture of Science and Technology Jessica Riskin, continued to be a core activity of the HSSST Doctoral Program. This year's series consisted of 22 speakers from such institutions as MIT, Harvard, New School for Social Research, Lancaster University, Colby College, University of Michigan, University College London, University of Chicago and Stanford, and covered a wide range of topics from "Human-Robot Interaction and the Future of Robots in Society," "Systems, Networks, and Webs: Toward a History of Digital Convergence," "African Fractals: Modern Computing and Indigenous Design," "Agricultural Biotechnology and Globalization," "The Legacy of Computer Science," "Why Did Celsius Think that Water Froze at 100 Degrees Celsius?" Professors Fitzgerald and Smith organized six brown bag lunch discussions for HSSST doctoral students and STS faculty. Three of these talks gave our faculty and students the opportunity to hear work currently in progress by HSSST faculty members Professors Hammonds, Keller, and Jean Jackson. Another gave our faculty and students the opportunity to meet with the director of a parallel interdisciplinary program at the University of Maastricht, The Netherlands. Professor Mindell continued work begun at his January 1999 MIT conference on Deep Water Archeology by holding monthly workshops that brought together archaeologists, engineers, and oceanographers from MIT and other institutions to discuss new deep sea technology.

The India/South Asia Forum, convened by Dr. Abha Sur, a Visiting Scholar in STS, continued for a second year with eight talks presented during 1999–2000. The sessions included such topics as "Rethinking Anti-Colonialism: Local Wars, Global Truces," "Contemporary Issues for Women's Movement in India," "South Asians in Silicon Valley: Some Field Notes and Thoughts," and "New Nukes: India, Pakistan and Global Nuclear.

KNIGHT SCIENCE JOURNALISM FELLOWSHIP PROGRAM

Now entering their eighteenth year, the Knight Fellowships continue to attract science journalists from around the world to learn more about the research and innovation they cover. During his second year as Director of the Program, Boyce Rensberger inaugurated a week-long intensive fellowship in molecular biology for science journalists, as well as a three-day program for editors. In addition, Rensberger secured an additional two million dollar endowment pledge grant from the John S. and James L. Knight Foundation.

The eighteenth class of Fellows includes Sahoon Hong, science reporter, Korean Broadcasting System; Akinlabi Jimoh, science writer, *The Guardian*, Nigeria; Sharon Kay, freelance science writer and producer, New York; Karen Rafinski, medical writer, the *Miami Herald*; Teresa Riordan, patents columnist, the *New York Times*; Gary Robbins, science writer, *Orange County Register*; California; Bari Scott, executive director, SoundVision Productions, Berkeley; Seema Singh, science writer *The Times of India*, Bangalore; Volker Steger, science photographer, Munich; Angela Swafford, writer and producer, Discovery.com.

Fellows attend over 60 seminars with faculty, which are specially organized for them, as well as other seminars and workshops devoted to science and technology and their wider impacts. The Fellowships are supported by an endowment contributed by the John S. and James L. Knight Foundation of Miami and by alumni and foundation gifts. More information about the Knight Science Journalism Fellowships can be found at http://web.mit.edu/knight-science/.

PROFESSIONAL ACTIVITIES

Professor Buchwald co-organized a Dibner Institute conference on technology; coordinated the Dibner Institute Fellows program; published an article in a book edited by Raine Daston for University of Chicago Press; inaugurated a new history of science and technology series with MIT Press (*Transformations*, first two books are in press).

Professor Dumit is revising his book manuscript *Whose Brain Is This? PET Scans and Personhood in Biomedical America* and co-chaired the STS colloquia series.

Professor Fischer was on leave during the spring term, published three papers, has three papers in press, and participated in two national conferences. He is stepping down as Director of MIT's STS Program as of July 1, 2000, a position he held for the past three and a half years.

Professor Fitzgerald completed her book, *Yeoman No More: The Industrialization of Agriculture*, (Yale University Press, in press).

Professor Gusterson published a book (co-edited with Jutta Weldes, Mark Laffey and Robert Duvall) entitled *Cultures of Insecurity: States, Communities,and the Production of Danger*, University of Minnesota Press; published an article called "Feminist Militarism" in *Political and Legal Anthropology Review.*

Professor Hammonds was elected Secretary of the MIT faculty for a two year term; appointed to the Faculty Policy Committee; taught four courses; organized for the fourth year the Joint MIT/Harvard Workshop on "Race" in the Histories of Science, Medicine and Technology; and was appointed to the editorial board of the journal *Signs.*

Professor Evelyn Fox Keller completed a book manuscript *The Century of the Gene* (Harvard University Press, in press). She organized and hosted (with Assistant Professor Ned Hall) a colloquium series in the History and Philosophy of the Life Sciences; received a Guggenheim Fellowship and two honorary degrees (Allegheny College; The New School University); and was Visiting Professor, Ecole Normale, Fall 2000. She published two new articles and wrote articles for conferences that will appear in published proceedings.

Professor Keniston directed the MIT-India Program, which sent 18 MIT students as interns this year to eight different sites in India; was Sir Ashutosh Mukherjee Visiting Professor at the National Institute of Advanced Studies, Indian Institute of Science, Bangalore, while he was on leave during the 1999 fall semester and published *Earth, Air, Fire, Water: Humanistic Studies of the Environment*, edited with Jill Conway and Leo Marx (University of Massachusetts Press, 2000).

Professor Mindell published *Technology, War, and Experience Aboard the USS Monitor* (Johns Hopkins University Press, 2000). In addition to having a book under contract with Johns Hopkins University Press on *A History of Control Systems: 1916–1945*, he published two conference proceedings, several journal articles, including "Opening Black's Box: Rethinking Feedback's Myth of Origin," *Technology and Culture*, and several chapters in edited books. In addition, Professor Mindell chaired, MIT's Independent Activities Period Policy Committee and served as a member of MIT's Committee on Undergraduate Program.

Professor Riskin served as the STS Undergraduate Academic Officer and co-organized, along with Professor Dumit, the STS Colloquia Series. She published a journal article, an essay, two encyclopedia articles, and a book review.

Professor Smith served as Acting Director of the STS Program during the spring 2000 term, and will become Director of the program for a two-year period beginning July 1, 2000. He continued to head the Sloan history textbook project, "Integrating the American Past: A New Narrative History of the United States," now in its final year. Professor Smith serves on various museum boards and committees, including Hagley Museum and Library, American Museum of Textile History, and The Thomas Edison Papers Project.

Professor Turkle continues to work on program development and fundraising for a new Center for Technology and Identity at MIT and received the Abby Rockefeller Mauze Professorship. She published several chapters in edited books, including "Toys to Change Our Minds" in *Predictions*, Sian Griffiths, ed.; published several articles, including "The Digital Future: From Rorschach to Relational Artifact" in the Radcliffe Quarterly, Winter 2000; and a report on "Tech-Savvy: Educating Girls in the New Computer Age," co-edited with AAUW Educational Foundation Commissioners, April 2000.

FUTURE PLANS

With the resignation of Professor Buchwald, STS hopes to fill the Bern Dibner Professorship of the History of Science during the 2000–2001 academic year. The task of reviewing the graduate program basic courses will continue during 2000–2001. We have also begun a serious review of the undergraduate offerings, and will continue to put into place a more coherent set and diverse range of subjects. We will also continue our efforts to teach and interact with units across the Institute.

More information about the STS Program can be found on the World Wide Web at http://web.mit.edu/sts/.

Merritt Roe Smith

CENTER FOR INTERNATIONAL STUDIES

The Center for International Studies promotes theoretical and applied international studies at MIT. The activities of the Center, established in 1951, have broadened since the end of the Cold War, reflecting a more complex international security and economic environment. At the same time, the increasingly critical role of science and technology in the analysis and conduct of public policy is affecting the social sciences, both analytically and substantively.

Major research and training units within CIS include the Security Studies Program, the Development Studies Program, the MIT Japan Program, and the MIT Science and Technology Initiative (MISTI) programs on China, Germany, France, India, Italy, and Japan. These established programs provide a rigorous base for new work on emerging issues. CIS traditional strengths in security strategies, development studies and political economy anchor major initiatives on international economic and social performance, technology policy and environmental issues, democratization and ethnic conflict, and migration and refugees. Outreach activities include Japan Program and MISTI internship training programs for scientists and engineers and Seminar XXI executive education programs for senior defense and foreign affairs officials.

The Center for International Studies includes 160 members of the MIT faculty and staff, and visiting scholars from other institutions, many from abroad. It is organized into formal programs, working groups, and individual research projects. Programs engage in a broad range of research and training activities related to their substantive concerns. Multidisciplinary working groups bring faculty, research associates, and students together around shared interests. Faculty members and research staff also conduct their own research projects under the auspices of the center.

MIT SECURITY STUDIES PROGRAM

The MIT Security Studies Program is a policy research and teaching component of the MIT Center for International Studies. It focuses on the security concerns of states. The program studies:

- how security threats are identified,
- how national security strategies are devised,
- the technologies, systems, and doctrines that are used to build and implement military power,
- the causes of wars, and
- the ways in which armed conflicts among states and within them can be avoided, contained, and terminated.

The MIT Security Studies Program has over 60 associates, including more than a dozen faculty members who devote essentially all of their professional attention to security issues. About half of the program's faculty members are natural scientists and engineers and half are social scientists, thus giving the program a strong interdisciplinary flavor. Thirty plus graduate students are affiliated with the Program, nearly all of whom are doctoral candidates in political science. In addition, more than 20 fellows are attached to SSP, including military officers from each of the armed services who receive war college credit for time spent at MIT, scientists and engineers from several countries who work on missile defense and nuclear weapons issues, and several senior scholars and former government officials.

Program research is built around the interests of the faculty, the dissertations of the graduate students, and occasional commissioned projects. The research categories are best expressed in a listing of the program's working groups—faculty led research teams that focus on the same general topic. There are six such groups.

- *Asian Energy and Security Working Group*—Led by Professor Richard Samuels, who directs both the MIT Japan Program and CIS, and Associate Professor Thomas Christensen, a China expert.
- *Conventional Warfare Working Group*—led by Professor Barry Posen, a political scientist noted for his work on grand strategies, military innovation, and, more recently, ethnic conflict.
- *Defense Technologies Working Group*—directed by Dr. George Lewis, a physicist and one of the Program's Associate Directors, and Professor Theodore Postol, a member of the MIT Science, Technology and Society Program and a nuclear engineer.
- *Defense Politics Working Group*—chaired by Professor Harvey Sapolsky and Dr. Owen Cote, Assoc. Director of the Program, also examines civil/military and interservice relations.
- *Future of the Defense Industries Working Group*—chaired by Professor Sapolsky, focuses on life after the Cold War for defense contractors and arsenals in both Europe and the United States.
- *Humanitarian Intervention Working Group*— offered jointly with Harvard and chaired at MIT by Professor Stephen Van Evera, a member of the Political Science Department and an international relations theorist.

Each year the program sponsors four to six conferences including an annual conference on airpower topics named after MIT graduate General Jimmy Doolittle (USAF), and another on nuclear weapons named after Vice Admiral Levering Smith. Summaries of program conferences are widely distributed.

In addition to conference summaries, the Program publishes a research journal, *Breakthroughs*; a seminar summary series, "SSP Seminars"; a monthly newsletter, *Early Warning*; and a working paper/occasional paper series. These are distributed via the Internet and a large mailing list. Several *Breakthroughs* articles have been reprinted by other publications and several working papers have been adopted for courses at other universities.

PROGRAM IN DEVELOPMENT STUDIES

The Program in Development Studies draws on social science faculty, scholars, and students from MIT and the Cambridge-Boston academic community to study salient issues of developing countries. With a multidisciplinary training and research agenda, the program sponsors workshops, interdisciplinary research teams, and individual scholarly efforts in a variety of substantive areas including:

- ethnicity and nationalism;
- international migration and refugee movements;
- poverty alleviation programs in developing countries;
- global environmental change;
- economic liberalism and trade reform;
- non governmental organizations; and
- transnational linkages between developed and developing countries.

The Program in Development Studies works closely with the Inter-University Committee on International Migration, established in 1974. This Committee brings together faculty members and research scholars from Boston University, the Fletcher School of Law and Diplomacy, Harvard, MIT, Tufts University, and Wellesley College concerned with migration and refugee studies.

With a multiyear grant (renewed this year) from the Mellon Foundation, the Committee runs a year-long seminar series and implements the Mellon-MIT Inter-University Program on Non-Governmental Organizations (NGOs) and Forced Migration, which provides competitively-awarded small grants for faculty, graduate students, and research scholars at member institutions to conduct research on this topic. The Committee also undertakes special projects. It completed a comparative study of US and Japanese migration, citizenship and refugee policies, funded by the Center for Global Partnership, with the publication by Macmillan and NYU Press of a volume entitled *Temporary Workers or Future Citizens? Japanese and US Migration Policies*, edited by the late Professor Myron Weiner and Professor Tadashi Hanami (Sophia University). A related project by the American Academy of Arts and Sciences on German-American Migration and Refugee Policies in which several members of the committee participated was also completed with the publication of a five volume series by Berghahn Press edited by Professor Myron Weiner.

Each year, a staff member of the Office of the United Nations High Commissioner for Refugees participates in the work of the Inter-University Committee on International Migration. In 1998 the Committee initiated the *Rosemarie Rogers Working Paper Series* with the publication of the study, "Missed Opportunities: The Role of the International Community in the Return of the Rwandan Refugees from Eastern Zaire," by Joel Boutroue of UNHCR. A total of 6 working papers have been published in the series, and another 2 are in press.

DEMOGRAPHY, ETHNICITY, SECURITY

With support from the Smith Richardson Foundation, the Program in Development Studies is completing a project on demography and security. Ten studies have been commissioned for a workshop that was held at the Center in late 1998 on the political consequences of demographic changes and the security implications of state policies to change demographic variables. Two books emanating from the project are in press with Berghahn Books. The first is a volume of essays co-authored by Professor Weiner and Dr. Michael Teitelbaum (Alfred P. Sloan Foundation) entitled *Political Demography, Demographic Engineering*. A second, containing the studies commissioned for the workshop, is entitled *Demography and National Security*, edited by Professor Weiner and Dr. Sharon Stanton Russell (CIS).

The *Project on Race, Ethnicity and Censuses*, conducted by Associate Professor Melissa Nobles (Political Science), examines the historical development of contemporary political battles over racial census categorization in the United States and Brazil. Both countries have long histories of immigration, both voluntary and involuntary, that are reflected in the categories and uses of census data. A conference at CIS, funded by the Sloan Foundation, brought

together scholars in the field. Professor Nobles' completed study, *Shades of Citizenship: Race and Censuses in Modern Politics*, will be published shortly by Stanford University Press.

DEVELOPMENT PROGRAM SEMINARS AND COLLOQUIA

- *The Joint Faculty Seminar on Political Development (JOSPOD)*—JOSPOD is co-sponsored by the MIT Center for International Studies and the Harvard Weatherhead Center for International Affairs. Suspended in 1999, JOSPOD is expected to resume in 2001.
- *The Inter-University Committee on International Migration Seminar Series*—The International Migration Seminar, chaired by Dr. Stanton Russell, explores the factors affecting international population movements and their impact upon sending and receiving countries and relations among them.
- *Mellon-MIT Inter-University Program on NGOs and Forced Migration* conducts a seminar series throughout the year featuring the work of persons who have received grants from the Mellon-MIT program.
- *Peoples and States*: *Ethnic Identity and Conflict*, chaired by Professor Jean Jackson (Anthropology), examines the issues of ethnic and nationalist identities in relation to the state.
- *The Emile Bustani Middle East Seminar*, a guest lecture series organized by Professor Philip Khoury (History and CIS), focuses on issues of peace, conflict, and democratization in the Middle East and North Africa.
- *The MacArthur Transnational Security Seminar*, co-sponsored by the MIT Center for International Studies and Harvard's Weatherhead Center for International Affairs, was initiated in 1996 with a grant from the John D. and Catherine T. MacArthur Foundation.
- *The Ford Methodology Workshop*, a seminar funded by the Ford Foundation, focuses on methodological issues in field research with presentations by faculty, guest lecturers and dissertation candidates.
- *Women and International Development (WID)*, a program jointly sponsored by the Center and the Harvard Institute for International Development, conducts seminars and workshops that address issues relating to women and international development.

MIT INTERNATIONAL SCIENCE AND TECHNOLOGY INITIATIVE (MISTI)

MISTI creates and supports programs that promote the internationalization of education and research at MIT. MISTI/China was launched in 1994, the first of a projected series of regional programs to enhance the ability of MIT students to acquire a deeper understanding of how knowledge is created and used in other countries. It also provides opportunities for MIT researchers to develop international collaborations with scientists and technologists at outstanding foreign institutions.

The principal objective of these collaborations is to expand core resources for studying other societies on campus and to share a growing MIT base of knowledge about foreign science, technology, and industry through outreach programs in the United States. Today MISTI has three programs in Asia China, India and Japan and three in Europe, Germany, Italy and France. The mandate of all the programs is to educate MIT scientists, managers and engineers in the language and culture of the country before placing them in "hands on" situations in the host country. The programs also conduct meetings, symposia, workshops and produce and disseminate research on pertinent topics.

Misti China Program

China was the first focus of the MISTI Program, offering opportunities for student internships in mainland China, Taiwan, and Hong Kong. Students work at public service organizations, laboratories, and multi-national corporations with subsidiaries in China. The program also facilitates collaborations between MIT faculty and researchers with their colleagues in outstanding universities and laboratories in China. Students are placed in diverse host institutions such as Tsinghua University, Fudan University, the Chinese Academy of Sciences, Intel Corporation, Lucent Technologies, IBM, Ingersoll-Rand, Roche Pharmaceuticals, and General Motors.

These internships are intended to serve as a first step in an individual's career path, not as a "study abroad" or "work abroad" program. Many MISTI interns return from China to take challenging jobs with the same or similar research organization and companies in the United States. They return with strong professional contacts and with what many companies have characterized as a "China expertise."

Mit Computer Education Technology Initiative

In 1997, MISTI sponsored a new student internship program: The MIT Computer Education Technology Initiative. The mission of MIT-CETI is to build cross-cultural understanding between the younger generation of Chinese and American students through the development of computer-related educational projects, thereby strengthening U.S.-Chinese relations in the future. Teams of 2 to 3 MIT students are sent to Chinese high schools for 6-week summer

projects which involve setting up Internet nodes, connecting the schools to the Internet, enabling chat rooms between Chinese and American students, and teaching web design courses to Chinese high school students.

Misti Germany Program
In 1996, MISTI launched the MIT Germany Program, modeled on the MIT Japan activities. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of German language and culture with their expertise in the fields of engineering, science, and management. The program places MIT students in German research institutions, companies, and government ministries. In 1997, MISTI placed 22 students in German companies and research institutes. Today the program sends more than thirty students to Germany each year.

Misti India Program
The MIT-India Program, was established through a pilot project in the summer of 1998 that sent six MIT computer science students to a high school in Pune, Maharastra. The interns connected students to the Internet, helped students and faculty create a school web site with local content, and taught students web-programming languages. Today more than twenty interns go to a variety of situations including working at banks, research institutes and hi tech companies.

Misti Italy Program
In 1998 MISTI launched the MIT Italy Program, modeled on the MIT Japan Program. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of Italian language and culture with their expertise in the fields of engineering, science, and management. The Program places MIT students in Italian research institutions, companies, and government ministries.

Misti French Program
In 2000 MISTI launched the MISTI French Program. It will provide internship opportunities for undergraduate and graduate students to combine their knowledge of French language and culture with their expertise in the fields of engineering, science, and management. The program places MIT students in French research institutions, companies, and government ministries.

MIT Japan Program
The MIT Japan Program established in 1981 is the largest most comprehensive program of its kind in the country. It routinely places MIT interns in Japanese laboratories after preparing them at MIT with two years of language and with courses on Japanese culture and history. The program currently sends between 30–40 interns to Japan each year. The program also conducts workshops, symposium and meetings, bringing together U.S. and Asian academics, government organizations, and corporations to address critical issues that arise in the areas of international science, technology, and management. Participants form networks to enhance understanding and effectiveness between the Japanese and U.S. science, technology and business communities.

Since its inception, the MIT Japan Program has sent more that 500 student interns to Asia. Today, more than half of those students are working with U.S. corporations. The internship program has two primary objectives:
- to launch students in their careers by fostering international skills and expertise, and more broadly,
- to develop a cadre of internationalists—specialists in technology and management—who can strengthen interaction and communication with Japan and East Asia.

Interns receive extensive training at MIT prior to going abroad, including a year long course on the history and culture of Japan and East Asia, and two years of Japanese language. This helps them hit the ground running, and puts them in an excellent position to acquire insider knowledge of science, technology, and management in Japan and East Asia.

Program sponsors place these bilingual, bicultural professionals in key positions in Japan, America, and East Asia to facilitate communication and to acquire technologies and management expertise. As their companies seek new opportunities in a dynamic Asian environment, many former MIT interns play a strategic role in creating networks that aid in the development of business partnerships and joint ventures.

The MIT Japan Program actively engages in policy research on Japan and East Asia. The Program's current research agenda is focusing on a comparative study of technology development in several East Asian nations: specifically whether a tsunami of converging practices-spread by networks of multinationals and international S&T

collaboration, empowered by the forces of global trade and finance- is eradicating nationally based differences in the organization of innovation, or if national differences will harden or persist.

In addition to providing its sponsors with uniquely trained global managers, the MIT Japan Program works with executives on strategy, and mid-level managers and engineers on tactics, in forging effective linkages with their Japanese counterparts. This information and advice is provided through "Target Seminars," both informal working groups and formal training sessions, that address such issues as building trust and effective negotiation with the Japanese.

The program also conducts an annual 3-day Executive Seminar for government, business, and technical managers who are directly involved with East Asian strategies and operations. Current topics include the Asian economic forecast, the future of the Japanese financial market, Asian opportunities for US firms, and China on the eve of the 21st century.

The program is continuing its long distance education through a long distance course that utilize self paced materials: CD-Roms, workbook and a case study book. In addition, it disseminates research and educational materials through a number of printed and electronic media, including the MIT Japan Program Working Paper series; the JPNET (Japanese Network) Project Self paced interactive CD's, workbook; and a case study book on Negotiation with the Japanese

CROSSCUTTING WORKING GROUPS

In addition to the formal programs, CIS research is conducted via crosscutting projects typically organized as working groups. Because many pressing international issues do not fit neatly within functionally or regionally defined category, center working groups link CIS programs to one another, to other groups within MIT, and to many outside institutions. Several of these groups are structured to link the efforts of social science professionals with those of engineers and natural scientists on problems of academic and policy significance. Examples of active CIS working groups include:

- *The MacArthur Foundation Transnational Security Project*
- *The Working Group on Nuclear Waste and Proliferation*
- *The Working Group on Asian Innovation and Crises*
- *The Inter-University Committee on International Migration*
- *The Asian Energy and Security Working Group*
- *The Uncertainty and Regulation Working Group*
- *The China Environment Working Group*

Political Economy, Energy and Environmental Studies

The Center for International Studies offers a variety of research and training programs on connections between politics and markets. One cluster of activity centers on national adaptations to a global economy, while a second cluster centers on security and environmental costs that may be external to markets. The activities described below include individual and collaborative faculty and student research, fellowship programs, and several workshops and seminar series. In addition, the center maintains an ongoing grant program for research on international energy and environmental policy. These are areas marked by controversy, and CIS faculty, research associates and students address problems in political economy, energy and environmental studies from an exceptionally broad range of perspectives.

National Adaptations to a Global Economy

Several projects and series examine national adaptations to an increasingly global economy, with attention to the economic and political implications of increasing integration of goods, technology, and capital markets.

The Harvard-MIT Joint Working Group on Transnational Economic Security examines the effects of globalization on the demand for private and public adjustment initiatives and the financial capacity of firms and governments to facilitate adjustment. Further, it looks at firm and governmental incentives to alter taxation, environmental regulations, and labor standards. In 1999–2000, the group was organized by political scientists Dr. William Keller and Associate Professor Kenneth Oye of MIT and economists Dani Rodrik and Jeffrey Frankel of Harvard. It is supported by the John D. and Catherine T. MacArthur Foundation.

CIS sponsors occasional seminars and workshops to probe issues of current importance. Some recent examples include:

January 2000, CIS joined with the Faculty of Law of the University of Tokyo and the Center for International Studies of ETH Zurich in a conference to examine sources of variation in nominally domestic regulations in the US, Europe and Japan and the effects of regulatory diversity on international movement of goods and capital.

May 2000, Professor Oye and political science graduate student Peter Evans presented a keynote paper on international export financing competition at an Institute for International Economics Conference on Export-Import Bank.

Responses to Security and Environmental Externalities

A second set of projects centers on how security and environmental costs external to markets might best be addressed. Debates over these issues break out into two broad positions. One line stresses potential causes of market failure, then turns to associated public policy responses. A second line stresses potential causes of regulatory failure, then turns to associated proposals for regulatory reform and/or deregulation. The research activities by CIS faculty and affiliates along these two lines are described below.

Asian Energy and Security Working Group: Michael Lynch continued his work with a team drawn from the Security Studies Program, MISTI and the Japan Program. They are examining security externalities associated with energy and infrastructure choices and to evaluate economic and military strategies for addressing these energy externalities. This group has been funded by the CIS innovation fund and by NEDO.

International Aid and Chinese Coal Combustion Projects: Two teams drawn from the departments of political science, urban studies and planning, chemical engineering, and the technology and policy program are examining local and international responses to Chinese coal combustion. These CIS joint projects with Tsinghua University, Taiyuan University of Technology, Tokyo University and the Swiss Federal Institutes of Technology (ETH) have been supported by the Center for Global Partnership, the Alliance for Global Sustainability, NEDO, and ABB.

Uncertainty and Environmental Decisionmaking: CIS Research Affiliates James Foster and former NRC Policy Division Director Lawrence McCray have been leading working groups on regulatory adaptation and on the credible assessment of scientific and technical information. Faculty members Assistant Professor Brandice Canes, Dr. Joanne Kauffman, Professor Oye, Professor Sapolsky, and Professor Eugene Skolnikoff have been participants in conferences and workshops. These activities have been supported by the Consortium on Environmental Initiatives.

WASHINGTON ACTIVITIES

The Center for International Studies operates three programs that focus on training and public policy-making. These are addressed to the military and intelligence communities, the State Department and Foreign Service, and to senior Congressional Staff.

Seminar XXI—Foreign Politics, International Relations and the National Interest: Seminar XXI is an educational program for senior military officers, government officials, and executives in the national security policy community. Its fundamental objective is to provide future leaders of the national security policy community with enhanced analytic skills for understanding foreign countries and the relations among them. Fellows learn to raise new questions and to recognize assumptions that underlie assessments of foreign societies confronting them as policymakers. The seminar explores key policy issues by examining countries and problems critical to American interests through a variety of paradigmatic lenses. At each session, eminent experts present alternative perspectives from which the given country or problem can be understood. The seminar seeks to provide concrete frameworks for examining how different paradigms suggest fundamentally different, even conflicting, answers to the questions American policymakers must resolve.

Kalker Seminars on American Foreign Policy: American diplomatic trainees of varying rank participate in a series of workshops dealing with critical issues in global affairs. The series brings together distinguished faculty from American and foreign institutions along with high-level State Department and other government officials. Each month diplomatic trainees focus on an in-depth discussion of major issues and American strategies appropriate to a turbulent contemporary global environment. Seminars are held at the State Department's Foreign Service Institute in the Washington, DC. Area.

Congressional Senior Staff Seminar: This annual seminar provides intensive briefings on a selected issue in science and technology policy for senior members of congressional staff In 1999, the seminar examined issues concerning the Internet including privacy, encryption, intellectual property rights, and the structural impact of electronic commerce on industrial sectors.

WORKSHOPS, LECTURES, AND SEMINARS

The Center for International Studies hosts a variety of workshops, lectures, and seminar series, many of which are open to the Boston area academic community and the public. A list of CIS lectures and seminars follows:

- *The Emile Bustani Middle East Seminar*
- *The Security Studies Program (SSP) Seminars*
- *The MIT/Harvard Future of War Seminar*
- *The Star Seminars*
- *General James H. Doolittle Workshop and Dinner*
- *Admiral Levering Smith Seminars*
- *The Ford Methodology Workshop*
- *The Seminar on Global Accords for Sustainable*
- *The MIT Japan Technology Forum Lecture*
- *The Joint Faculty Seminar on Political Development (JOSPOD*
- *Inter-University Seminar on International Migration*
- *Peoples and States: Ethnic Identity and Conflict*
- *Kalker Seminars on American Foreign Policy*
- *The MacArthur Program on Transnational Security*
- *Lecture Series on Gender and Politics*

GRANT PROGRAMS

The Center for International Studies administers a variety of fellowships for social science doctoral students at MIT. Five are administered directly by the Center for International Studies:

- Mellon-MIT Inter-University Program on NGOs and Forced Migration
- International Energy and Environment Policy Research
- MacArthur Transnational Security
- Inter-American Foundation
- National Science Foundation Democratization Program

In addition to these, CIS serves as the point of contact for three national competitions:

- SSRC/International Predissertation Fellowship
- Luce Foundation Fellowships (also open to seniors, recent alumni, and junior faculty)
- National Security Education Program (NSEP)

During 1999–2000, CIS provided substantial support for approximately 15 graduate students from several departments through these fellowship programs, in addition to the internships provided via MISTI and MIT Japan for undergraduates.

PUBLICATIONS

In addition to the publications of the Security Studies, Japan and MISTI Programs, the Center publishes a bi-annual newsletter, *Precis*, and several working paper series. These include *CIS Working Papers*, the *Rosemarie Rogers Working Paper Series* (formerly the *Migration Working Paper Series)*, and the *MacArthur Transnational Security Working Papers.*

PERSONNEL

CIS Director Kenneth Oye and Executive Director William Keller, SSP Director Harvey Sapolsky, Japan Program Director Richard Samuels, and MISTI Director Suzanne Berger, continued to serve in these roles. The Development Studies program is seeking faculty to replace the late Myron Weiner as director; Sharon Stanton Russell continued to oversee the administration and guidance of its various components. Professor Oye is passing the baton of CIS directorship to Professor Samuels, who returns this fall from sabbatical to resume his teaching in Political Science. Professor Van Evera will serve as Associate Director. Staff members hired in the past year include Robin Macdonald (MISTI China), Harlene Miller (SSP), and Lakshmi Nayak (MIT India). CIS draws personnel from the MIT faculty and student body and recruits through the MIT Personnel Department. Our personnel reflect the general

commitment of MIT to affirmative action goals. In the nine most senior CIS management positions, CIS currently utilizes one Asian American male and four women.

More information about this center can be found on the World Wide Web at http://web.mit.edu/cis/.

Kenneth A. Oye, William Keller

PROGRAM IN WOMEN'S STUDIES

Women's Studies redresses the invisibility of women and gender in the construction of knowledge and reminds us to include women's as well as men's contributions, experiences and perceptions in understanding the world. The inclusion of Women's Studies subjects in the curriculum of an MIT student helps to produce an engineer, scientist, or business executive who is better equipped to contribute fully and participate effectively in teams made up of men and women.

The program is directed by Margery Resnick, Associate Professor of Hispanic Studies. During academic year 1999–2000, the Women's Studies Steering Committee consisted of Professor Isabelle de Courtivron (Foreign Languages and Literatures), Associate Professor Evelynn Hammonds (Science, Technology and Society), Associate Professor Sally Haslanger (Philosophy), Professor Jean Jackson(Anthropology), Professor Henry Jenkins (Literature and Comparative Media Studies), Professor Evelyn Fox Keller (Science, Technology and Society), Associate Professor Anne McCants (History), Professor Ruth Perry (Literature), Associate Professor Margery Resnick (Chair), and Associate Professor Elizabeth Wood (History). Ex-officio members of the steering committee are: Associate Head Librarian and Collections Manager for Women's Studies Marlene Manoff (Humanities Library), and Women's Studies Program Coordinator Michèle Oshima. The Curriculum Committee consisted of professors Assistant Professor Aixa Cintrón (Department of Urban Studies and Planning), Professor Haslanger, Associate Professor Diana Henderson (Literature), Professor McCants (Chair), and Assistant Professor Lora Wildenthal (History) The Programming Committee consisted of Assistant Professor Thomas DeFrantz (Theater Arts), Professor Hammonds (Chair), and Professor Jenkins. The Advisory Committee consisted of Professor Ellen Harris (Music), Professor Nancy Hopkins (Biology), Professor Molly Potter (Brain & Cognitive Science), Associate Professor Bishwapriya Sanyal (Department of Urban Studies and Planning), and Professor Robert Silbey (Chemistry).

The Program in Women's Studies offers an undergraduate curriculum consisting of core classes and cross-listed subjects from several departments. Students may concentrate, minor and petition for a major departure in Women's Studies. The Program in Women's Studies offered twenty-three subjects during the academic year 1999–2000, with approximately 300 students enrolled. The curriculum was enriched by the following six new subjects taught by faculty in several units: "Gender, Power and Development" (Assistant Professor of Anthropology, Christine Walley), "Literary Interpretation: Virginia Woolf's Shakespeare" (Professor Henderson, Literature), "Medieval Literature: Medieval Women's Literature" (Assistant Professor of Literature, James Cain), "Problems in Cultural Interpretation: Children's Culture" co-taught by Professor Jenkins (Literature and Comparative Media Studies) and Associate Professor of Media Arts, Justine Cassell, "Traditions in American Concert Dance: Gender and Autobiography" (Professor DeFrantz, Theater Arts), and "The Science of Race, Sex, and Gender in the United States" (Professor Hammonds, STS). Professor Resnick also taught the first Women's Studies subject, "International Women's Voices" on-line this spring through which MIT students shared background material, writing, and conversation on four novels with a university class in Germany for six weeks. Professor Haslanger (Philosophy) and Professor Wildenthal (History) received the Class of '51 Fund for Excellence in Education, Class of '55 Fund for Excellence in Teaching, and Class of '72 Fund for Educational Innovation, for revisions to the "Introduction to Women's Studies" subject at MIT. Professor Resnick conducted independent study subjects with four students. Professors Wildenthal and DeFrantz conducted independent studies with one student each. Women's Studies had one major this year. Professors Ceasar McDowell (Urban Studies and Planning) and Walley (Anthropology) advised this student on his Women's Studies thesis research. In addition, Professor Wood was the representative for the program to the Graduate Consortium in Women's Studies (GCWS) which she co-chaired. This year, the GCWS offered three graduate level courses, in which one MIT graduate student enrolled.

In celebration of the 15th anniversary of the MIT Program in Women's Studies, in October, Women's Studies sponsored a Dar Williams Concert that filled Kresge Auditorium.

"Is Multiculturalism Bad for Women?" A panel discussion with Susan Okin (Stanford), Martha Nussbaum (U. of Chicago), Abdullahi An-Na'im (Emory), Homi Bhabha (U. of Chicago), Leila Ahmed (Harvard). Moderated by MIT Professor Joshua Cohen was sponsored by the Boston Review, MIT Program in Women's Studies, MIT Political Science, authors@mit, the Technology and Culture Forum, and the Princeton University Press.

A reading series featuring local author and MIT Assistant Professor Helen Elaine Lee reading from *Water Marked* and visionary and author Susie Bright reading from *Full Exposure* was cosponsored by authors@mit and the MIT Program in Women's Studies.

Women's Studies sponsored the following events through the McMillan-Stewart Lecture on Women in the Developing World: "Making African Documentaries: Challenges for Women Directors" by African award-winning filmmaker Anne-Laure Folly and "Obscure Desires? The direction of the look as a content variable: Reflections on the practice of an African woman filmmaker" by Tsitsi Dangarembga. In conjunction with the last lecture, the MIT African Students Association and Women's Studies cosponsored a screening at MIT of "Everyone's Child" by Tstisi Dangarembga on children orphaned by AIDS in Zimbabwe.

The science fiction reading by Connie Willis and Nalo Hopkinson, was cosponsored by the Communications Forum, Comparative Media Studies, and LSC.

Women's Studies co-sponsored the Center for Bilingual/Bicultural Studies program "Eastern Europe: Memoirs, Memory, History," a panel discussion featuring Marianne Hirsh, Eva Hoffman, Susan Suleiman and moderated by MIT Lecturer Monika Totten.

Women's Studies supported Foreign Languages and Literatures Program: "¿Qué cuentan las mujeres en Cuba?: Narradoras de los años 90." Maria Luisa Campuzano.

"Women in Electoral Politics" A panel featuring Laura Liswood, Nancy Korman, and Massachusetts State Representative Liz Malia was moderated by Professor Wood.

"Feminism without Women? Against the Effacement of Sexual Difference" A talk given by Sylviane Agacinski was cosponsored by FL& L and Women's Studies.

"Women in Athletics", with a screening of "A Hero for Daisy" by Mary Mazzio on women and title XI at Yale, followed by a panel of MIT Women Alumnae: Institute Professor and former Secretary of the Air Force Sheila Widnall '60 and Astronaut Cady Coleman '84 was cosponsored by the Program in Women's Studies, the Department of Athletics, the Dean of Student Life and the Webster-Mauzé Fund in the Provost's Office.

Women's Studies students arranged a series of film screenings (*Daughters of the Dust, A League of Their Own, Silence of the Palace, Clockwatchers*, and *Diary For My Love*) followed by discussions.

Women's Studies co-sponsored two of the Comparative Media Studies colloquia: "Picture of Innocence: The History and Crisis of Ideal Childhood by Anne Higgonet", and "Barbie, Youth Violence, Queer Sex, and Censorship: Mixing it Up" by Erica Rand. In addition "Media, Madness and Morals," a discussion led by Jennifer Gonnerman and Tanya Selvaratnum was also cosponsored.

The "Black Performance Theory: Performativity and Narratives of Race" the working group featuring public components with MIT Professor Thomas DeFrantz (Chair), Annemarie Bean, Jennifer DeVere Brody, Richard Green III, Monique Guillory, John Jackson, Jr., Marya McQuirter, Anna Scott, Carl Hancock Rux, Christalyn E. Wright, Anita Gonzales, Jason King, Pamela Means and Amatul Hannan was cosponsored by Theater Arts, the Council for the Arts, Women's Studies, MIT Dean for Student Life, and the MIT Committee of Race Relations.

MIT Office of the Arts and the MIT Program in Women's Studies cosponsored "Love in a Post Claustrophobic Era: Reflections on 'Salad of the Bad Café'" a performance lecture, by Split Brtiches' Peggy Shaw and Lois Weaver and Asian American performance artist Stacy Makishi.

The Hip Hop Fest 2000 with music by Native Sound and Performances by the Untouchables, Twin Poets, The Artists of Pro Ghetto Entertainment, The Havnotz, Dangerous Minds was cosponsored by the MIT Program in Women's Studies, MIT Fund, Spice Fund, Office of Minority Education, the Council for the Arts, and the Campus Committee on Race Relations.

A special concert of Latino music featuring Flory Jagoda, Elliot Jagoda and Susan Feltman was cosponsored by MIT Hillel, Office of the Dean of Undergraduate Education and Foreign Language and Literatures.

In conjunction with the subject "Race and Gender in Asian America," Women's Studies presented a panel on Asian American Queer Women's Sexuality featuring Selena Wahng, Cecilia Tan, and Sonali Gulati and moderated by Ashwini Sukthankar.

A Women's Collective Concert featuring Jess Klein and the Nields was cosponsored by Women's Studies, the MIT Women's Collective and LSC.

Women and Hair, panel of students cosponsored with Hillel, MIT Women's Collective and Women's Studies.

RESEARCH, PUBLICATIONS, AND SERVICE

The Women's Studies Faculty continued their active contributions to their individual fields. Most of their accomplishments are listed in the reports of their home departments, so special attention is given here to achievements relating to work on gender.

Professor Isabelle de Courtivron (FL&L) published a review on a biography on Colette in the NY Times. Associate Professor Margery Resnick (FL&L) is the president of the International Institute in Spain, where she ran an international symposium on women's health issues. She gave the following talks: "This Is Not Your Father's MIT" to an MIT alumni club; "The History of Women's Studies: Challenges and Perspectives on Women's Studies Programs"; and "Women Writers and The New Spain." Assistant Professor Emma Teng (FL&L) served on the National Advisory Board of the Women's History Museum: An Institute for the Future.

Professor Evelyn Fox Keller (STS) published "From 'Gender and Science' to 'Language and Science,' in *L'Invention du Naturel: Les sciences et la fabrication du feminin et du masculin* and has written the following articles for conferences: "Tolerating Ambiguity" and "Whole Bodies, Whole Persons?" She gave Addresses (some of them "Keynote"): "Reproduction at the end of the Millennium," and "Feminisms and Rhetorics." Associate Professor Evelynn Hammonds (STS) was appointed to the editorial board of the journal *Signs*. She gave the public talk: "The Logic of Difference: Race and Gender in 19th century Surgery." She also received grants from the Ford Foundation and the Andrew W. Mellon Foundation to establish the MIT Center for the Study of Diversity in Science, Technology, and Medicine.

Professor Susan Slyomovics (Anthropology) was on leave in Morocco AY2000. During this time, she guest-edited a special issue of MERIP, "Morocco in Transition" which included her article, "A Truth Commission for Morocco?"; an interview with Fatna El Bouih (Moroccan feminist); and excerpts of Professor Slyomovics' translation of her prison memoirs, *Dhakirat al-nisyan*. She published the following review: *Women and the War Story*, by Miriam Cooke in *Middle East Studies Association Bulletin*. She served on the Advisory Board of *Women and Performance: A Journal of Feminist Theory*. Assistant Professor Christine Walley (Anthropology) presented the following conference paper: "'Culture' and the Global Debates over Female Genital Surgeries" on the panel entitled "Female Genital Cutting: Local Dynamics of a Global Debate" for the American Anthropological Association Meetings.

At a meeting (Mexico) of Latin American women playwrights, Associate Professor Brenda Cotto-Escalera (Theater Arts) identified ways to increase their visibility in the international arts community. She directed Abe Rybeck and Noelia Ortiz Cortes in a full production of *Immaculate Infection*, a piece created collaboratively by all three for The Theater Offensive. Professor Cotto-Escalera also consulted with the True Colors Out Youth Theater program of The Theater Offensive. Assistant Professor Thomas DeFrantz (Theater Arts) was the founding artistic director of "The Usual Suspects," the resident acting company of The Theatre Offensive. He convened the working group and performance "Black Performance Theory" at MIT.

Assistant Professor Helen Elaine Lee (Writing and Humanistic Studies) published her novel, *Water Marked*. She published the following pieces: "An Interview with Helen Elaine Lee" in *Callaloo: Gay, Lesbian, Bisexual, Transgender Literature and Culture*; "Claiming Identities" in *Black Renaissance/Renaissance Noire*; and "Writing to Live" and "Excerpt from *Water Mark*" in *Essence Magazine*. She read from *Water Marked* at many venues across the country including libraries, universities, bookstores and professional organizations. She served as associate fiction editor of *Callaloo*.

Associate Professor Justine Cassell (Media Arts and Sciences) published the following chapters in books: "Children as Designers of Interactive Storytellers: Let me tell you a story about myself . . . " coauthored with M. Umaschi Bers, M. in *Human Cognition and Social Agent Technology*; "Nudge Nudge Wink Wink: Elements of Face-to-Face Conversation for Embodied Conversational Agents" in *Embodied Conversational Agents* and she published the following paper in a refereed journal: "More than Just Another Pretty Face: Embodied Conversational Interface Agents" in *Communications of the ACM*. She was a guest speaker at the University of Vermont, Women's Studies Program.

Associate Professor Anne McCants (History) presented the following talks: "The Transmission of assets and family networks: managing the property and care of orphans in eighteenth century Amsterdam," and "Petty Debts and Family Networks." She published the following articles: "The Not-So-Merry Widows of Amsterdam, 1740–1782," in the *Journal of Family History*; and "Individual Life Chances Within the Rural Norwegian-American Family, 1850–1910," coauthored with Jon Gjerde in the *Journal of Interdisciplinary History*. She published a review of Benjamin Roberts, *Through the Keyhole: Dutch Child-rearing Practices in the 17th and 18th Century, Three Urban Elite Families* in the *Journal of Interdisciplinary History*.

Professor Ruth Perry (Literature) published three articles on women in eighteenth century literature in collected volumes published this year, and two of her essays "Radical Doubt and the Liberation of Women" and "De-Familiarizing the Family; Or Writing Family History from Literary Sources" were reprinted. She serves on the Dean's Committee on Gender Equity at MIT. Professor Henry Jenkins (Literature and Comparative Media Studies) spoke at the Console-ing Passion Conference.

Associate Professor Sally Haslanger (Philosophy) published the following pieces: "Gender, Race: (What) Are They? (What) Do We Want Them To Be?" in *Noûs*; "Feminism and Metaphysics: Unmasking Hidden Ontologies" in the *APA Newsletter* on Feminism and Philosophy; "What Knowledge Is and What It Ought To Be: Feminist Values and Normative Epistemology," *Philosophical Perspectives*; and "Feminism and Metaphysics: Negotiating the Natural" in *The Cambridge Companion to Feminism in Philosophy*. She has been appointed to the Editorial Board for the Studies in Feminist Philosophy book series at the Oxford University Press. She gave the following departmental colloquia: "You Mixed? Racial Identity without Racial Biology" and "Theorizing Gender and Race: Does (Feminist) Method Make A Difference?"

Professor Cintrón (DUSP) has left MIT and will join the faculty of Fordham. Professor Wildenthal (History) has left MIT and will join the faculty of Texas A&M.

FUTURE PLANS

Professor Resnick will serve as director through June 30, 2001. Active programming for Women's Studies for 2000–2001 is underway, and the Program will continue to stress the study of women in the international sphere.

More information about this program can be found on the World Wide Web at http://web.mit.edu/womens-studies/www/.

Margery Resnick

DEAN, SLOAN SCHOOL OF MANAGEMENT

The MIT Sloan School of Management had enjoyed a year of positive growth and development in many arenas during the academic year 1999–2000. Sloan's mission is to be the leading academic source of innovation in management theory and practice. MIT Sloan aspires to develop effective, innovative, and principled leaders who advance the global economy and to conduct rigorous and innovative research that improves management theory and practice. Sloan's mission, along with our uniquely close linkages with the rest of MIT, position the School exceptionally well in today's global, entrepreneurial economy. This is an extraordinary time for Sloan.

Capital Campaign

One of the most significant efforts of this past year was the launch of MIT's $1.5 billion capital campaign. Sloan plays an integral role in that campaign with our top priority being new facilities. A major investment in the future, the campaign will fund three critical areas – people (endowments for chairs and fellowships), programs (including education and research initiatives) and facilities.

On October 28, 1999, Sloan Alumnus William A. Porter, founder and chairman emeritus of E*Trade, and his wife Joan announced their contribution of $25 million toward a new Sloan facility to be named the William A. Porter Management Center. We would like to see Sloan housed in facilities that match the quality of our students, faculty, staff and programs. Bill and Joan's extraordinary vision and generosity put us a giant step closer toward achieving that goal.

Student Programs

Sloan continues to draw the nation's top students to its ranks. The School is rewarded and enriched by the diversity of its student body. The MIT Sloan student body consists of more than 1,100 graduate and undergraduates from approximately 70 countries. The entering MBA class of 2001 consisted of 96 women and 260 men, including 135 international students and 83 members of minority groups. The average age of entering students was 28 years, with an average of five years of full-time work experience.

The incoming class this year was particularly well "wired." It was the first class of any business school required to apply on-line. The students built an on-line global community even before they set foot on campus. They published newsletters, created an indexing system to retrieve messages, and arranged gatherings worldwide, establishing tight-knit, synergistic groups well before most students traditionally meet.

Students ran an extremely successful 11th annual MIT $50K Business Plan Competition. There was a 37 percent increase in the number of teams participating (206) this year with more than 1,000 people attending the final ceremony. This competition is run and entered by students from all over campus providing a rich intermingling of academic disciplines. The competition was heralded by more than 40 media stories on this year's contest, bringing worldwide attention to MIT and the program.

Students also held the Second Annual eBusiness Awards, garnering entries from around the world. This contest doubled its attendance and media coverage from the previous year.

Students in the Sloan 2000 Leadership Forum inaugurated a day-long leadership conference. Speakers included Duane Ackerman, BellSouth CEO and Sloan Fellow alumnus, and Howard Gardner, Harvard professor and author of the bestseller "Leading Minds." Ackerman also was selected by the students as the Sloan Distinguished Alumni Lecturer this year.

The Lemelson-MIT Program awarded the student prize for inventiveness to Amy Smith, Masters candidate in the Technology and Policy Program. A new team prize for innovation in telecommunication and networking was awarded to MIT students Michael Lim, Jalal Khan and Thomas Murphy.

Alumni Involvement

Alumni involvement continues to grow. More than 900 alumni volunteered their time and talent to Sloan this past year. Sloan set records for reunion attendance and for reunion class gifts. The School held its first alumni leadership conference for volunteers from around the world, providing volunteer training and recognition.

New Faculty and Honors
Sloan continued to expand its faculty with several new appointments, and current faculty received a number of honors and awards. The new appointments included Jonathan W. Lewellen as Assistant Professor of Finance, and S.P. Kothari as the Gordon Y Billard Professor of Accounting and Finance.

Several faculty honors of note include the following.

Ernst R. Berndt, Louis Seley Professor of Applied Economics, was named chair of the newly established Federal Economic Statistics Advisory Commission (FESAC).

James M. Utterback, MIT Sloan School Professor of Management and Engineering, was honored as a new Foreign Member of the Royal Swedish Academy of Engineering Sciences in Stockholm last fall.

Edgar H. Schein, Sloan Fellows Professor Emeritus of Management and Senior Lecturer, received a Lifetime Achievement Award in Workplace and Performance from the American Society for Training and Development (ASTD).

Lotte Bailyn, T Wilson (Class of 1953) Professor of Management, was awarded an Honorary Doctorate in Business Administration from the University of Piraeus in Greece for her "significant contribution to the advancement of Business Administration theory and practice."

The Universidad de San Martin de Porres de Lima awarded Thomas A. Kochan, George M. Bunker Professor of Management, a Doctor Honoris Cause for his "outstanding personal merits and extraordinary professionalism and human quality."

Stewart C. Myers, Gordon Y Billard Professor of Finance, received an honorary doctorate from the London Business School of the University of London in July for his outstanding intellectual contribution to management and business studies.

Journal of Business Strategy (September/October 1999) named Senior Lecturer Peter Senge a Strategist of the Century, one of 24 men and women whom the journal regards as having "had the greatest impact on the way we conduct business today."

Research Centers
Sloan launched the New Economy Value Research Laboratory with a pledge of $10 million from the firm Arthur Andersen. This lab, under the direction of Professor S.P. Kothari, will study creation, management and measurement of value in the new economy, looking at risk management and how the financial markets measure value.

The Center for eBusiness @MIT, created in 1999, attracted 15 corporate sponsors in its first year, who collectively pledged approximately $20 million to support the Center's educational and research programs over the next three years.

The five-year research program "Inventing the Organizations of the 21st Century" presented its findings in a day-long symposium in November 1999, outlining faculty views of promising organizational structures of the 21st century.

International Initiative
Fudan University in Shanghai graduated it first class of 38 International MBA students in January, the second school in Sloan's China Management Education Project to graduate a class. Beijing University's first class graduated last spring and Lingnan (University) College's first graduation is yet to come. This program allows faculty and students at Sloan to be at the forefront of knowledge of Chinese business development and has established a first-class curriculum at these top Chinese universities.

Organizational Changes
At the beginning of the academic year, Sloan established the Office of Alumni and Corporate Relations, merging two separate areas, with Ron Thomann as Executive Director. Jackie Wilbur was appointed the new Director of the Career Development Office, and Al Essa became the new Executive Director of Information Technology. *MIT Sloan*

Management Review appointed Professor Michael Cusumano to chair its board of directors and named Allan Alter as the new editor-in-chief.

Business School Rankings
While Sloan continues to run its programs independent of outside ratings, Sloan monitors the ratings as a form of feedback. *U.S. News and World Report* ranked the undergraduate program first in the nation in August 1999. After the close of this academic year, *Business Week* announced that MIT Sloan had moved up 11 slots in its ranking of business schools to fourth place. This is the same place Sloan holds in the 2000 *U.S. News and World Report* survey of the top MBA programs, and the *Financial Times* 2000 survey of the world's business schools. Both rankings moved Sloan up from fifth place in prior surveys. In *Forbes* magazine's first ranking of business schools, Sloan was rated sixth.

2001 Priorities
As Sloan pushes ahead to 2001, the School's top priorities continue to be the capital campaign and new facilities for the school. Plans are also under way for Sloan's 50th anniversary celebration scheduled for Fall 2002.

More information about the MIT Sloan School of Management and its programs can be found on our web site at http://mitsloan.mit.edu/.

EDUCATION

MBA PROGRAM

Our mission is to create and deliver a small MBA program based upon collegiality and teamwork, an international focus, and a diversity of cultures and interests. The innovative and integrative curriculum aims to provide a strong analytical foundation to management, encourage the interplay of ideas and their practical application, and allow students to design an individualized educational program exposing them to leading-edge research and practice.

At the beginning of the 1999–2000 Academic Year, the Sloan MBA Program administrative units were restructured and consolidated. A new Executive Director position was created, and Margaret Andrews (a Sloan '92 alumna) was hired in August 1999, with strategic planning responsibility for the overall MBA Program as well as responsibility for the integrated operations of the MBA Admissions, Student Affairs, and Career Development Offices. This transition brought the MBA Program's three key administrative offices under the same executive manager for the first time in recent memory, and initiated a busy and productive year.

MBA Admissions Office
This has been another highly successful year for Sloan Admissions. The new MBA Class of 2001 is made up of 356 students, including 49 Leaders for Manufacturing joint Sloan/Engineering candidates. Continuing the trend of the past several years, the class is an experienced one, having an average of five years of employment before matriculating. The average age is 28 years. Average GMAT score has risen to 695 (median is 700).

Sloan continues to be a diverse population on all dimensions. The incoming class is 38% international (47 countries are represented), 27% women, and 9% underrepresented minority students. Twenty-nine members of the first-year MBA class are from underrepresented minority groups. The Class of 2001 includes 17 African-Americans and 11 Hispanic-Americans; they joined 27 second-year minority students.

In addition, students have come from all over the United States with backgrounds in engineering, mathematics, economics, political science, history, languages, international studies, social science, business, publishing, law, computer hardware and software, communications and transportation. Many are already entrepreneurs who have founded their own businesses.

The number of applications fell slightly this cycle to 3,164, reflecting a leveling off of candidates for MBA programs in general and the effects of a continuing expansionist trend in a strong economy. Nonetheless, as business becomes more complex and reaches into sectors that were previously less business-oriented, such as health care, we continue to see a diversification of our applicants to include doctors, lawyers, architects and other professionals who find themselves in need of sophisticated management skills to complement their professional expertise. This year's applications came from all 7 continents, including Antarctica.

Plans for the coming year include building on the virtual community developed by the incoming students, our first class of applicants to apply exclusively on line, as well as continuing our traditional recruitment events and activities

worldwide. The voluntary participation of current students and alums in these efforts gives evidence of the satisfaction with our program.

MBA Student Affairs Office

Academic Year 1999–2000 was a challenging and successful one for enrolled MBA students and the Student Affairs Office staff serving them. Overall full-time MBA student enrollment at Sloan, including Leaders for Manufacturing, is 720 (624 MBAs and 96 LFMs). The fall of 2000 marks the end of a two-year revamping process for the MBA curriculum involving current students, alumni/ae, faculty, the Dean's Office, industry representatives, and administrators. This final phase of the Core 2000 redesign and rollout includes the addition of an introductory marketing elective in the Fall Core which complements the finance elective put into place in 1999. Room was made in the core for these two elective options by the reconfiguration of the Organizational Process course into a half-term format as well as final adjustments to the content of the Economic Analysis for Business Decisions, Accounting, and Data, Models and Decisions courses.

After students complete their required fall core requirements, they then choose a specific Management Track or Self-Managed Track, all of which require the completion of a sequence of extended 'Spring Core' electives common to all the Tracks in addition to each Track's specialized electives. The Core 2000 initiative also encompassed changes in the Spring Core; the required sequence format for the 2000 Spring Core was expanded from one '4-of-6' series to two '3-of-5' sets of subjects.

The School currently has a roster of seven Management Track offerings (Financial Engineering, Financial Management, Strategic Management and Consulting, Information Technology and Business Transformation, Manufacturing and Operations, eBusiness, and New Product and Venture Development). More than two-thirds of graduating MBA students completed a Management Track in academic year 1999–2000, with an especially strong enrollment demonstrated by students drawn to the New Product and Venture Development Track's emphasis on entrepreneurship and new product marketing. Students who did not join one of the seven tracks noted above opted for the Self-Managed Track, which provides them with maximum flexibility of course selection and the ability to customize their program following completion of the Fall Core.

The Minority Business Club and Minority Student Support Group met regularly during the academic year to discuss minority student issues. The MBA Program again subsidized the membership of minority students in the National Black MBA and National Hispanic MBA associations, allowing students to attend national conferences. Résumé books were developed for both groups and were used at career fairs for these events.

U.S. News and World Report ranked the Sloan MBA Program #4 in the nation in its 2000 annual survey of graduate business schools published in March, up from #5 in 1999. The program's continued high rankings (#3 in 1998, #4 in 1997, #2 in 1996) are recognition of our student selectivity, high graduation rate, career placement success, and academic reputation.

MBA students, faculty, and staff participated in three School-sponsored international trips last year. The international trips continue to be an important part of the MBA Program student experience, and are collaboratively organized by students, the MBA Student Affairs Office, and International Management faculty. The trips are preceded by an academic seminar that examines the relevant management, social, and cultural issues of the countries visited. The trip destinations last year were Brazil and Argentina; Jordan, Egypt and Lebanon, and China. More than 120 MBA students participated.

MBA Career Development Office

The 1999–2000 Academic Year was a notable one for the Career Development Office. The CDO offered 65 seminars/workshops on 21 different topics during 1999–2000. Subjects ranged from an overview of effective career management to self-assessment, resume development, networking, conducting a proactive job search, managing relationships with employers, interviewing, negotiating, evaluating offers and making final career decisions. Five new seminar topics were introduced to address special search issues: visa issues of international students, finding a job with a start-up, hands-on negotiation practice, and finding housing in NYC.

From October through May, CDO staff held more than 650 individual counseling appointments, in addition to answering regular questions on a drop-in basis. Support for more than 175 alumni seeking new career opportunities were also provided during this period of time.

The career development office coordinated the logistics for over 90 corporate presentations and over 245 interviewing companies. In addition, the CDO successfully attracted 83 new firms to recruit our students during the 1999–2000 academic year; these firms participated in traditional recruiting processes as well as through newly developed career fairs.

At graduation, 97% of the Class of 2000 reported receiving a job offer. The median starting salary for accepted positions increased to $90,000 from $85,000 in 1998. Fourteen percent of the Class of 2000 chose to join a start-up or are in the process of starting their own companies. This is an increase of 6% from 1998.

The CDO is well positioned to build on these successes in the 2000–2001 academic year. New initiatives for 2000–2001 include developing separate and distinctive career services for each class; involving key corporate friends in the career education process; developing and delivering a new approach to resume development and review; closer coordination with the MBA Student Affairs Office to enhance the career education process within each Management Track; and enhanced recognition of employer contributions to Sloan.

LEADERS FOR MANUFACTURING

The Leaders for Manufacturing (LFM) Program is a partnership between MIT and over 25 global manufacturing firm to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now in its 12th year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students both as fellows in the program (with fully-paid tuition) and as research assistants throughout the Institute. The largest component of the educational efforts is the Fellows Program, a 24-month dual-masters degree (engineering and management) experience involving a single integrative research project carried out on site in partner firms.

Forty-eight students in the class of 2000 completed the Fellows program and 66% have taken positions in manufacturing firms. Twenty-eight students have taken positions with one of the LFM partner companies. Intel was notable for a large number of hires from the class.

Each of the 48 graduates completed an internship at a partner company during the summer and fall of 1999. Internships are focused projects of concern to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included the launch of a Ford production IT system; applying lean manufacturing principles to a virtual business; and implementing a kanban card for a manufacturing plant, which reduced inventory, streamlined the products' material flow, and resulted in a $50,000 savings.

Forty-eight students (Class of '01) completed their first year of on-campus studies and are starting their six-month internships. Forty-seven new students (Class of '02) were admitted and have begun an intensive summer session. All of these students have an average of approximately 5.3 years of practical work experience.

Bea Mah Holland, who holds the position of Director of Leadership for the Sloan School and LFM, officially joined MIT full-time early in fiscal year 2000. She has significantly increased activity in the classroom about the concept of leadership and what it means for industry.

Research has been conducted with seed funding from LFM in the following areas: Product Life Cycle Analysis, Scheduling and Logistics Control, Variation Reduction, Design and Operation of Manufacturing Systems, Integrated Analysis and Product Development, Culture and Organizational Change, and the Next Generation Manufacturing project. Each area has both a faculty and an industry leader. The groups focus on detailed issues of benefit to several member companies, but with implications for many companies. On-site student interns have played a valuable role in teaming with on-campus researchers to more effectively define problems, gather data, and analyze it. Midstream and end-of-internship presentations convey research results to MIT and partner company personnel. This past year the Integrated Supply Chain Management partner companies participated in the scheduling and logistics presentations.

The three-year study, "The Utilization of LFM Graduates," conducted by Jan Klein, Senior Lecturer in the Sloan School of Management, includes research findings of interviews with alumni, supervisors, and managers from each company that has utilized LFM graduates and students. These companies include ALCOA, Boeing, Chrysler, Compaq (formerly Digital), Kodak, Ford, GM, HP, Intel, Motorola, Polaroid, and UTC. This past year the study was expanded to include MIT faculty, which resulted in the interviewing of over fifty MIT faculty.

LFM now provides all LFM theses in a word search format on its website, http://lfm.mit.edu/.

The National Coalition for Manufacturing Leadership (NCML), a partnership of fourteen Universities with joint management and engineering programs, hosted a joint recruiting forum (the National Manufacturing Recruiting Forum) sponsored by the University of Michigan. Over two hundred students and seventy companies participated in this event. LFM made a significant contribution to the NMRF by developing a robust, web-based interview scheduling system that increased interview scheduling efficiency and was applauded by students and companies alike. The NMRF has been very popular with Coalition partner companies and will be repeated each year. Representatives from the Coalition meet each year to share curriculum, research, and program best practices.

Table 1. Placement
Class size: 48 students
(10 Partner Company sponsored students; 1 non-Partner Company sponsored student; and 37 non-sponsored free agents.)

	# Hired	% of Class
Partner Companies	28	58
Other Mfg. Companies	4	8
Total Manufacturing	32	66
Consulting/Banking	6	13
Other Operations	3	6
Other	7	15
Total employed graduates	48	100
Free agents hired by Partner Companies	19	40

Students accepted positions with the following companies:

- LFM Partner Companies: ABB, Alcoa, Boeing, Dell, Eastman Kodak, Eaton, Ford, GM, Honeywell, HP, Intel, Motorola, UTC.
- Other Mfg. companies: Johnson & Johnson, Medimmune, Nippon Stryker, Valeo.
- Consulting/Banking: Bain, BCG, Diamond Technology Partners, Goldman Sachs, McKinsey, PRTM.
- Other Operations: Amazon.com, BellSouth Corporation, IronRhino.com.
- Other: iCompass, I2 Technologies, Jinni Inc., Maxager Technology, Syncra Systems, Inc., Ten Fold.

EXECUTIVE EDUCATION

Sloan's Office of Executive Education has continued its efforts to probide superior programs to key partner companies and alumni of executive education, drawing on Sloan's reseach depth and expertise to help managers and executives solve important business problems. The offerings of Executive Education increased greatly during the year responding to the demand for open-enrollment courses and for customized programs.

Both the Sloan Fellow and Management of Technology programs, flagship programs for executive education at Sloan, successfully recruited large classes for 1999–2000, indicating continuing strong demand for these mid-career management degrees. (See separate reports that follow.)

Five executive short courses of five days each were successfully presented in May and June. A two-week course on Latin American business was run in October and will be offered again in response to enthusiastic demand. And the portfolio of open enrollment two-day courses has increased dramatically over the year.

Responding to market demand for more customized programs, Sloan increased its offerings of executive education programs for individual companies, particularly partnership companies such as Merrill Lynch. Sloan Executive Education is working with a set of companies on programs addressing the issues of change management, information technology, ebusiness and financial engineering. An important trend is incorporating new learning technologies into most programs. The Office of Education now includes a director of learning initiatives.

More information on executive education at Sloan can be found on the World Wide Web at http://mitsloan.mit.edu/execed/.

Susan C. Lowance

MANAGEMENT OF TECHNOLOGY PROGRAM

The MIT Management of Technology Program (MOT), the first joint program between the Sloan School and the School of Engineering, was established in 1981 to develop leaders who will create the linkages between their organizations' underlying technology and overall strategy. The 12-month program grants the special degree SM in Management of Technology. In addition to providing executive development for strong technical leaders who are taking on senior leadership positions in their firms, the program has also attracted an increasing number of participants who are involved in entrepreneurial opportunities.

The MOT Class of 2000 included 52 participants from 18 countries. They averaged 11 years of work experience, representing a wide variety of industries and functional expertise. More than 70% of the participants were sponsored by their organizations during their year at MIT. More than half of the class had advanced degrees prior to joining the MOT Program, most in technical disciplines. This year's annual program evaluations yielded the highest student satisfaction ratings in the history of the MOT Program.

This past year, domestic field trips provided the MOT class an opportunity to visit leading high technology firms on both coasts of the United States. In November, the annual trip to New York included visits to telecommunications, pharmaceuticals, financial services, media, electronic commerce and technical consulting organizations. In January, the group spent a great week in Silicon Valley, visiting a wide array of large and small technology-based firms, venture capitalists and intellectual property consultants. While large firms such as Netscape, Intel, Sun Microsystems, Hewlett-Packard, Agilent, and Oracle provided great insights into how technological innovation is implemented, much was also gleaned from visits to smaller firms, particularly those involved in the very competitive electronic commerce marketplace.

In March 2000, the MOTs set out for the "Wireless Valley" of Scandinavia, arriving just as the world began to explore the intersection of mobility and Internet technology. Following an excellent kickoff in England, which included visits to the British Parliament, and Cambridge University (taking advantage of the new partnership between Cambridge, MIT and the British Government) the group toured Norway, Sweden and Finland. Visits to such telecommunications titans as Nokia and LM Ericsson, along with petroleum giants like BP Amoco and Statoil, provided an interesting backdrop for visits to smaller, innovative firms. Companies such as Cambridge Display Technologies, FAST Search & Transfer, IDEO, and THINK Norway (a Norwegian electric vehicle plant, now fully owned by Ford Motor Company) all provided a perspective on how entrepreneurship works in a global context. Visits to Egg Financial Services, OM Stockholm Stock Exchange, and MeritaNordbanken helped MOT students explore the impact of Internet technologies on the financial sector.

More information about the MOT Program can be found on the World Wide Web at http://mitsloan.mit.edu/mot/.

David A. Weber

SLOAN FELLOWS

The Sloan Fellows program is the oldest degree granting executive education program in the world. Begun in 1931 with the backing of several industrialists, it was designed as an innovative 12-month graduate program covering the fundamentals of management and managerial decision-making. Now approaching its 70th year, the program has evolved over the years to keep abreast of a changing world and has remained the leading choice among the world's top corporations to prepare today's managers to be tomorrow's leaders. The individuals designated as Sloan Fellows are fully sponsored by their organizations during their 12-month stay in Cambridge.

The program continues to make a significant contribution toward achieving the Sloan School's strategic objectives: to develop effective, innovative and principled leaders who advance the global economy and to conduct rigorous and innovative research that improves management theory and practice.

In support of the first objective, the program attracts and educates individuals from corporations that are industry leaders from around the world. The class of 2000 represented 19 U.S. and 38 foreign organizations, many of which have long associations with MIT. The class formed a diverse, mutual-learning community from which individuals

took away not only the analytical tools necessary to perform, but also the intellectual confidence to help them to make the right decisions in the complex environments they face. Addressing the second objective, through an active alumni network, strong partnerships with sponsoring organizations and the Sloan Fellows' thesis work, Sloan faculty have enjoyed many opportunities to conduct research in which to improve management theory and practice.

The class of 2000 represented 20 countries, providing an excellent opportunity for cross-cultural exchange. A record eleven Sloan Fellows were women in 1999–2000. The number of applications in 1999–2000 increased by 10% over the previous year, with increased applications from Europe, continued strong interest from Asia and Latin America, and a good balance of public and private institutions.

The newly designed Web site has begun to alter the way the program is promoted and how information is disseminated to prospective candidates. This will continue to evolve by design in the coming year, and, together with improvements in the marketing database used by the Office of Executive Education, should contribute to expanding the pool of candidates to be Sloan Fellows and identification of new organizations to participate in the program. Program staff participated in key industry conferences and made a number of corporate visits in order to increase visibility of the program. Additional emphasis will be given to increasing conference participation and corporate visits in the coming year.

Active participation by Sloan Fellow Alumni in program and MIT events continued. The Seminar in Leadership series, and the annual Sloan Fellow Field Trips to New York, Washington, and an International Trip to Japan, China, and Hong Kong all provided opportunities for alumni to take an active role as speakers and hosts. A high point of the year was hearing the MIT 2000 commencement address given by a Sloan Fellow, Carton S. Fiorina, SF'89, President and Chief Executive Officer of Hewlett-Packard.

The newly re-constituted Board of Governors for the Sloan Fellows Program met twice during the year and provided valuable guidance and direction to the program. They looked into how distance learning technology may affect the delivery of education in general and the Sloan Fellows program in particular. They also discussed how the topics around e-business are being integrated into the curriculum.

1999–200 saw some changes that we would also like to report. At the end of the year, Professor D. Eleanor Westney was named as the faculty chair, succeeding Professor John Van Maanen. Also at the end of the year, the director of the Sloan Fellows Program, Toby Woll, was named to a new position, Director of Learning Technology Initiatives within the Office of Executive Education. Stephen Sacca (SF'90), became the new Director of the Sloan Fellows Program. Finally, looking forward to 2000–2001, Faculty and Program staff will undertake a comprehensive program review.

More information about the Sloan Fellows Program can be found on the World Wide Web at http://mitsloan.mit.edu/sf/.

Stephen Sacca, Toby Woll

DOCTORAL PROGRAM

Sloan's doctoral program aims to provide institutions in the united states and abroad with outstanding management faculty and researchers. On the output side, we graduated 13 people this past academic year with job success and placements being quite good in all of our management fields. Recent graduates have found positions at Harvard, Columbia, Yale, Washington University in St. Louis, Insead (France), Brigham Young University, and MIT. Although two graduates succumbed to the blandishments of industry, most remain committed to academic careers.

On the input side, we experienced another record-breaking year, due in part to the ease of access to our Web page (http://mitsloan.mit.edu/) and the application form availability via this method. We received 534 applications from 58 countries, 36% from China. We made 26 offers and got 13 acceptances (50% yield). Total enrollment now stands at 88, with 54 international and 34 US, and a total of 22 women. While the number of under-represented minority students remains small at three active students, we continue initiatives begun three years ago to increase our diversity, including participating in the KPMG Peat Marwick PhD Project (an annual recruitment event). We also continue to explore other means to increase the participation of minority students in Ph.D. studies here.

Sharon Cayley

SLOAN VISITING FELLOWS PROGRAM

The MIT Sloan Visiting Fellows Program provides the opportunity to pursue full-time, non-degree studies tailored to individual goals and interests. Each Visiting Fellow's program of study, usually for one or two semesters, is designed in consultation with a faculty adviser to meet individual professional needs and interests.

Sloan Visiting Fellows is a small program. Participants usually have an existing relationship with the school through their company, their school or a member of the Sloan faculty. Enrollment per semester averages around twelve. Eleven participants were enrolled in fall 1999 and seven in spring 2000.

The 1999–2000 academic year included both self-sponsored and company sponsored participants as well as visiting students from the Norwegian University of Sciences and Technology and also the Digital Institute of Technology in Munich. In addition, Graduates of the Management of Technology (MOT) Program continue regular participation in the Visiting Fellows Program as a second semester or year of sponsored study.

Sponsors of participants included Bank of Tokyo-Mitsubishi, Ltd., Scandinavian Airlines, Site Design Co., Ltd., Norwegian University of Sciences and Technology and also the Digital Institute of Technology in Munich.

More information on the Sloan Visiting Fellows Program can be found on the World Wide Web at http://web.mit.edu/.

Jennifer Mapes

SYSTEM DESIGN AND MANAGEMENT PROGRAM

The mission of System Design and Management Program is to educate future technical leaders in architecting, engineering, and designing complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily at a distance.

The SDM Program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a Master of Science degree in Engineering and Management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education format for company-sponsored students, requiring one academic semester in-residence at MIT; and a 24-month, on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers. The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

Co-directors for the program include Paul Lagace (Engineering), Steve Graves (Management), and Bill Hanson (Industry) and John Williams (Engineering) until his sabbatical in January 2000. In June, Thomas Kochan from the Sloan School also continued in the combined enterprise as a co-director filling in for Steve Graves' during his sabbatical.

In June 2000, SDM graduated its second full class. Forty-five of the 58 graduates attended the commencement ceremony to receive their degrees—a tribute to the cohesiveness of this distance education group. The graduating class includes 17 employees from Ford, 12 from UTC and three from Xerox, and two from Kodak, as well as employees from Fuji Xerox, ITT, PictureTel, Intel, USAF, ComputerVision, Silicon Graphics, Sun MicroSystems, Comicrom SA, and Honeywell.

In January 2000, SDM admitted its fourth class, enrolling 50 students. Forty-three students admitted in 1999 continued in the program, with three 13-month students from the January 1999 class graduating in Spring 2000. In all, 12 companies sponsored students in the incoming class, including four sustaining enterprise companies: United Technologies Corporation sponsored four students, Ford Motor Company sponsored 13, Xerox Corporation sponsored six, and Eastman Kodak sponsored two students. Other sponsoring companies include: NASA which sponsored seven students for the first time, Polaroid, Delphi Packard, U.S. Navy, IBM, Intraware, Integrity Solutions and Mide Technology.

Table 2. SDM Student Statistics

	1997	1998	1999	2000
ADMITTED	35	58	47	50
ON-CAMPUS	8	16	6	14
SELF-SUPPORTED	3	1	2	5
RESEARCH ASSISTANT	3	12	2	4
DISTANCE EDUCATION	27	42	41	36
COMPANY SPONSORED	29	45	43	41

Specific program accomplishments included the following.

SDM admitted the fourth class of 50 SDM students. 54 students graduated from the 1998 distance education program for new careers in systems as well as graduating three thirteen-month students from 1999 class. All but one of the 1998 students have now graduated and many students have successfully parlayed their SDM education into new positions in their companies—these promotions occurred either while they were in the SDM program or after graduation. The Program Office has begun the process of exit interviews with this group of newly graduated students. SDM continues to support the student council to work on student concerns and issues that are unique to the SDM program. Student council initiatives this year included planning for the International Business Trip and establishing a student committee to more fully utilize the time spent on Business Trips.

SDM continues to develop its three core subjects in system architecture, system engineering, and system and project management. Ed Crawley, the faculty for System Architecture, was provided with additional TA support to work on further improvements in the course. Additionally, a curriculum committee has been re-instituted for SDM to begin to look at the curriculum. This effort will be the first review of the curriculum since the program's inception in 1996. At the June LFM-SDM Workshop, committees were formed to look at five initiatives meant to strengthen the LFM and SDM programs. SDM-specific initiatives include a team looking at the SDM value proposition and curriculum and a team studying the effectiveness of distance education.

SDM shares its placement resources. Although sponsored SDM graduates will return to their companies, unsponsored graduates will typically seek new careers in systems engineering and product design. LFM-SDM offered placement services to all non-sponsored SDM students. SDM leads an effort to replicate its product development track at other universities to help them develop and introduce an SDM-like program. Together with Ford, IBM, ITT, RIT, UDM, the U.S. Navy, and Xerox, SDM and CIPD have formed a consortium called PD21: The Education Consortium for Product Development Leadership in the 21st Century, to disseminate the product development curriculum to other universities. SDM has taken a lead role in the consortium1999 saw the first cohort of students enter similar programs to SDM at Rochester Institute of Technology and University of Detroit Mercy. Both schools successfully recruited a second cohort that began in January 2000. A new consortium member, the Naval Postgraduate School, will matriculate its first cohort in September 2000.

SDM delivers the full range of its course offerings to both on-campus and remote students, including three core systems courses, six fundamental courses, and five elective courses satisfying SDM's design, engineering, and management elective requirements. The faculty have substantially adapted other courses for the distance education medium of multipoint videoconferencing to as many as 15 simultaneous company sites.

SDM continues to provide web support for faculty and students as well. The COMMAND System, developed by John Williams and a lab of research assistants, has been used successfully since the inception of the program. SDM is looking at further ways to use the web to support its faculty and students.

SDM is experimenting with new distance formats. When SDM students could not get into Rebecca Henderson's Technology Strategy course because of over enrollment, SDM program administrators created a course format in which SDM distance students receive the core of Henderson's teaching while not necessarily having direct access to her time throughout the semester. The alternative, which relies heavily on traditional distance education technology, includes using taped classes from Henderson's previous semester on-campus class and live, videoconferenced recitations with high-level graduate students serving as teaching assistants. The format also featured a two-day workshop on campus during which Henderson devoted herself entirely to SDM students who travelled to MIT

LFM/SDM: "A Partnership For The Total Enterprise"

As reported last year, after much discussion and consultation with the Deans of Engineering and the Sloan School of Management, on July 1, 1999, Leaders for Manufacturing and System Design and Management Program officially

consolidated their administrative staff. Much energy has been devoted during the last year not only to achieve the economy of scale planned for by the consolidation, but also to understand how these two related programs can work more effectively for the LFM-SDM partnership as a whole.

One of the first actions taken by the new LFM-SDM partnership was to advertise for the position of Director of Fellows (SDM). Created to mirror the position held by Don Rosenfield in LFM, the Director of Fellows (SDM) reports to the LFM/SDM co-directors, has primary responsibility for the overall SDM program and involves both administrative and teaching responsibilities within the SDM program. Dennis Mahoney, a retired captain in the Navy (engineering duty) began serving in this position on August 1, 1999.

As a newer program within the Institute, SDM has already benefited considerably by its association with LFM. Processes already established by LFM have been adapted to SDM, including entrance and exit interviews and greater emphasis in the admissions process in collecting data for determining profiles of successful SDM students. A new effort was begun to get placement and salary data of graduates in an effort to determine what the experience of SDM graduates were after the program in partner companies and in companies that hire non-sponsored SDM students. The Operating Committee and Governing Board for LFM assumed oversight of the SDM program, and began the process in fiscal year 2000 of bringing advocates for both programs onto these boards. Because there was little history of industry partnership for SDM, much work still needs to be done in this regard. Of the four SDM enterprise partners (Ford Motor Company, United Technologies Corporation, Eastman Kodak Company, and Xerox Corporation), only Xerox was not a partner with LFM, but has since been invited to join as a full partner of LFM-SDM.

Much time over the last year has been spent determining the future direction of this new entity within the Institute. Beginning with a two-day off-site with co-directors in June 1999, this effort led this year to the production of a White Paper entitled, "A Strategic Vision: Building on and Strengthening the LFM-SDM Programs." LFM-SDM have chosen the phrase "Leaders for the Total Enterprise" (LFTE) as the central concept around which to build the next generation LFM and SDM programs.

LFTE maintains and builds on the unique bases of LFM and SDM and thereby allows the interdisciplinary issues facing organizations to be effectively addressed in a broader context while still maintaining our originals focuses on issues in the more local domains. The new larger partnership of LFTE allows LFM-SDM to continue to address the two key discipline areas of engineering and manufacturing (product design, development and delivery) while broadening our domain and thereby learning about and developing the practices and principles that occur at the interface and integration of these disciplines.

There are five thrusts to developing LFTE:

- Developing principles and practices for the Total Enterprise, which includes as all the people and entities along an organization's value chain that are involved with the design, development, manufacture, and distribution of a product or family of products.
- Developing a strategy for knowledge management. This includes knowledge generation, development, and transfer.
- Lifelong education, including developing the educational supply chain,
- Distance education, including the use of new technologies to support lifelong education and educate the many and the few.

After discussion with all the partners and stakeholders, it was determined that while there was interest in how a combined LFM-SDM might develop in the future, stakeholders were focussed on how LFM-SDM might strengthen the two individual programs. Accordingly, LFM-SDM held a faculty retreat in June, attended by faculty, students, alums, partner companies and staff. This year's topic "Strengthening and Building on the LFM and SDM Programs" was driven by the need to continually adjust the programs to meet the changing needs of all our partners--students, alumni, faculty, and industry.

After a full day of brainstorming, the group determined five initiatives that it wanted the partnership to address within the next six months. These initiatives included:

- Revisiting the LFM mission/vision
- Clarifying the SDM value proposition/vision
- Re-instituting SDM's curriculum committee, composed of company, faculty, and
- Students, to articulate and define the program's fundamental intellectual underpinnings

- Distance education
- Defining and enhancing lifelong learning for both LFM and SDM

Global teams consisting of representatives from all stakeholder constituencies have been formed and are working on addressing these issues over the long term.

Current LFM-SDM Co-directors are: Stephen C. Graves, William C. Hanson, and Paul Lagace.

More information about LFM and SDM can be found on the World Wide Web at http://lfmsdm.mit.edu/.

William C. Hanson

TEACHING PROGRAMS

UNDERGRADUATE PROGRAM IN MANAGEMENT SCIENCE

Seventy-one seniors majoring in management science were graduated during 1999–2000 academic year, two in February and 69 in June. Of those 71 seniors, 39 choose the option in finance, 18 selected information technologies, three choose marketing research, and eleven selected operations research.

Twenty of our students received simultaneous S.B. degrees from other MIT departments. Eleven received S.B. degrees from the Department of Electrical Engineering and Computer Science, six from the Department of Economics, and three from the Department of Mathematics.

Four students were triple S.B. degree recipients: one from the Departments of Economics and Mathematics, two from the Department of Computer Science and Electrical Engineering and the Department of Mathematics, and one from the Departments of Physics and Mathematics.

At a post commencement reception, the School recognized June graduate David F. Yang with the Sloan School of Management Senior Prize. Awarded to outstanding seniors majoring in Management Science, this annual prize honors students who achieved high scholastic standing and demonstrated leadership and professional promise.

Enrollment in the undergraduate program has more than doubled since spring 1994. At the end of spring, term there were 267 students enrolled in the Management Science SB Programs. Of these, 49 are pursuing their primary SB degrees in other MIT departments. The Sloan SB program is now the fifth largest undergraduate major at MIT, larger than most of the undergraduate majors in the School of Engineering, and larger than all but the biology major in the School of Science.

A large number of undergraduates from other MIT degree programs continue to enroll in management subjects. (The exact number is difficult to tally separately from current program enrollment because many of these students will add a Sloan SB to their current primary SB degree before graduation.)

Independent Activities Period

During January 2000 Sloan offered a number of IAP activities: Professor Arnoldo Hax led a seminar titled "Strategic Consulting Toolkit." Dr. William Lucas taught a seminar in "Basic Social Science Methods for Management Research." Professor Barbara Bund offered "Marketing: an Introduction for Entrepreneurs," and Professor John Harrald of George Washington University led " Group Exercise in Hindcasting." Three entrepreneurial subjects were offered: Senior Lecturer Russell Olive offered "Personal Entrepreneurial Career Strategy and Preliminary Venture Analysis." Visiting Lecturer Frank Zenie offered "Starting and Building a Successful Technology Based Company." Senior Lecturer Joseph Hadzima presented "The Nuts and Bolts of Business Plans." Professors John Little and Tom Magnanti presented a series on "What is Management Science? What is Operations Research?" and Professor Nelson Repenning led a series of sessions on "Management Business Dynamics." (Beginning this coming academic year, IAP will be coordinated by Sloan's Educational Services Office.)

UNDERGRADUATE ADVISING AND COMMITTEE ASSIGNMENTS

Faculty who served as undergraduate advisers included Professors Thomas J. Allen, Daniel Ariely, Paul Asquith, Dimitris J. Bertsimas, Paul Carlile, Chyrsanthos Dellarocas John deFiguueriedo, Stephen Graves, Denis Gromb, Leigh Hafrey, Neal Hartman, John Little, Stuart Madnick, Michael Mikhail, Stewart Myres, J.D. Nyhart, Jim Orlin, Ed Steinfeld, John VanMaanen, Roy Welsh; Dr. Jeffrey A. Meldman, Director of Undergraduate Programs; Heather M. Madnick, Assistant Director of Undergraduate Programs; and Etaine Smith, our new Assistant Director of Undergraduate Programs. Professor Carroll continued as departmental coordinator of MIT's Undergraduate

Research Opportunities Program (UROP) and Neal Hartman as departmental writing coordinator for Phase Two of the Institute WritingRequirement. Etaine Smith also served as an advisor to MIT freshman.
Faculty serving on the Undergraduate and Interdepartmental Policy Committee included Professors Allen, Graves, Gromb, Madnick; together with Dr. Meldman, Ms. Madnick and Ms. Smith. Professor J. Carroll served ex officio and Professor J. Little chaired the committee.

Jeff A Meldman, Etaine Smith

RESEARCH CENTERS AND GROUPS

CENTER FOR COORDINATION SCIENCE

The MIT Center for Coordination Science conducts multidisciplinary research to help understand how information technology can provide new ways of organizing human activity and help people work together better. Primary funding comes from a variety of government sources, including DARPA and NSF. The center also has corporate sponsorship from Fuji Xerox, Intel, and British Telecom.

The past year has brought significant progress on both the center's main research areas. The Process Handbook research area made significant advances in a collaborative project focused on "supply chain visualization." This project is integrating the process knowledge management functionality of the Process Handbook with tangible user interfaces (from the MIT Media Lab) and process simulation tools (from the MIT Systems Dynamics Group). The Adaptive Systems and Evolutionary Software research area made significant progress in the area of exception handling and norms for multi-agent systems.

More information about this center can be found on the World Wide Web at http://ccs.mit.edu/.

Thomas W. Malone

CENTER FOR ENERGY AND ENVIRONMENTAL POLICY RESEARCH

The Center for Energy and Environmental Policy Research (CEEPR) has been the locus of research at MIT on energy economics since the mid-1970s and on environmental economics since the late 1980s. This research draws on resources from the Sloan School, the Department of Economics and the Energy Laboratory, and it receives financial support from corporations and government agencies. In conjunction with MIT's Center for Global Change Science, CEEPR co-sponsors the Joint Program on the Science and Policy of Global Change, which conducts interdisciplinary research to inform global climate policy.

The most notable event during the year was publication of *Markets for Clean Air: the U.S. Acid Rain Program*, co-authored by Denny Ellerman, Paul Joskow, Dick Schmalensee, Juan Pablo Montero and Elizabeth Bailey. This book reports CEEPR's research on SO_2 emissions trading during the first three years of the program, and it is the definitive source of information and analysis concerning the U.S. experience in using tradable permits to achieve environmental goals.

In addition, seven working papers and eight article reprints, reporting CEEPR-sponsored research, were published, distributed, and posted on the CEEPR website. In November 1999 and March 2000, CEEPR convened its usual Energy and Environmental Policy Workshop in Cambridge to present research results to corporate and government sponsors and other interested parties. Also, in June 2000, the Center co-sponsored a workshop on electric utility restructuring in Spain in conjunction with a Spanish electric utility.

During the year, the director and executive director of CEEPR were invited to make numerous lectures and other presentations of CEEPR's research and to participate in various advisory and expert groups. Of particular note, the executive director was invited to Japan as MIT's Mitsui lecturer in November 1999 on the subject of emissions trading.

In 1999–2000, CEEPR sponsored research on the topics of SO_2 emissions trading, new electricity markets, productivity improvements in crude oil supply, and energy futures, forwards and arbitrage. Most of the research effort was devoted to emissions trading and electricity markets, and this emphasis will continue during the 2000–2001 academic year.

More information about this center can be found on the World Wide Web at http://web.mit.edu/ceepr/www/.

A. Denny Ellerman

INVENTING THE ORGANIZATIONS OF THE 21ST CENTURY

Inventing the Organizations of the 21st Century was a five-year research and education initiative that concluded in December 1999. A major symposium reviewing the results of the initiative was held in November 1999.

More information about this program can be found on the World Wide Web at http://ccs.mit.edu/21c/.

Thomas W. Malone

LABORATORY FOR FINANCIAL ENGINEERING

The focus of the Laboratory for Financial Engineering is the quantitative analysis of financial markets using state-of-the-art mathematical, statistical and computational models. The LFE's goals are to spur advances in financial engineering and computational finance; and to support curriculum development for financial technology in undergraduate, graduate and executive educational programs.

The LFE has received major funding support for its activities from Merrill Lynch this year as part of the five-year MIT/Merrill Lynch partnership announced in March 1999. As a result, several new research initiatives will be launched, including the following: Trading Costs and Liquidity Project; Global Financial Crises Project; Risk Preferences Project; Financial Visualization Project; and Nonlinear Financial Time Series Analysis Project.

Thanks to major funding support from the MIT/Merrill Lynch Partnership, the LFE has been able to expand its research focus in number of new directions, in addition to making progress on several existing projects. In particular, the LFE launched three new initiatives last year: the Risk Preferences Project, the Global Financial Crises Project, and the Marketing by WebMarkets Project. The Risk Preferences Project involves theoretical, empirical, and experimental analysis of the risk preferences of investors, and includes collaborations with cognitive scientists, computer scientists, and professional traders at two local financial institutions. The Global Financial Crises Project is an attempt to develop a systematic framework for understanding the mechanisms by which financial crises in one institution or country is transmitted to others. The Marketing by WebMarkets Project is a collaboration between faculty in the Department of Brain and Cognitive Sciences, Sloan Finance, and Sloan Marketing departments in which artificial financial markets are proposed as a more efficient and cost-effective alternative to standard marketing surveys to elicit consumer preferences.

In addition, there has been considerable progress in each of the existing projects of the LFE: Trading Volume Project; Derivatives Project; Derivatives Sourcebook Project; Risk Management Project and Nonlinear Financial Time Series Project.

These projects and their corresponding preprints and reprints, along with LFE staff and affiliated faculty, are described in more detail at the LFE's web site http://lfe.mit.edu/.

The MIT/Merrill Lynch partnership also includes an important educational component, the Financial Technology Option (FTO), a new graduate minor in financial technology that has been jointly developed by the Sloan School of Management and the Department of Electrical Engineering and Computer Sciences in the School of Engineering. The program's intent is to provide training in financial engineering for MIT graduate students from technology fields such as engineering, math, computer science and media studies. The minor will increase financial applications within the School of Engineering's technology courses and boost the number of technology courses available to MBA students in Sloan's Track in Financial Engineering. This is the first year of the FTO and approximately 35 students have signed up for the option.

Research support for the LFE has been generously provided by a number of industry sponsors and donors, including sponsors: FleetBoston, Gifford Fong Associates, Lehman Brothers, Merrill Lynch, National Science Foundation, Putnam Investments, Silicon Graphics, and Sun Microsystems; and donors: Harris & Harris Group, and Morgan Stanley Dean Witter.

More information about the LFE's research program can be found on the World Wide Web at http://lfe.mit.edu/.

Andrew W. Lo

MIT ENTREPRENEURSHIP CENTER

The mission of the MIT Entrepreneurship Center is to train and develop leaders who will make high-tech ventures successful. To that end, we offer educational programs to inspire, educate, and coach new generations of entrepreneurs from all parts of MIT. To support this mission, MIT's Entrepreneurship professors, practitioners and

staff teach more than a dozen courses and conduct basic research to enhance our fundamental understanding of the dynamic process of high-tech venture development in the United States and around the world.

The MIT Entrepreneurship Center was launched as an Institute-wide initiative in 1996. At that time, President Vest said, "We must not only be the best. We must also serve as a model for others and ensure that, together, we all make a significant global impact in this vital field." To achieve these objectives set out by our President, we established two goals: to recruit ten leading professors and practitioners and to raise $60 million in endowment to fund their teaching and research.

Since then, our ranks have grown as we continue to recruit world-class educators. In fiscal year 2000 we recruited experienced entrepreneurs Noubar Afeyan '87 and Shari Loessberg as Senior Lecturers. We also engaged five tenured or tenure-track faculty members: Diane Burton, Assistant Professor of Management of Technology, Innovation and Entrepreneurship (MTIE); Richard Locke, Alvin J. Siteman Associate Professor of Management, Political Science, and Entrepreneurship; Fiona Murray, Assistant Professor of MTIE; David Scharfstein, Dai-Ichi Kangyo Bank Professor of Management; and Antoinette Schoar, Assistant Professor of Finance.

In fiscal year 2000 the Center sustained its rapid growth, increasing student enrollment in entrepreneurship courses while launching new courses, student activities, and faculty initiatives. From 1996 to 2000, student enrollment in Entrepreneurship courses grew from 288 to 1086. In the same period, the center increased its recurring course offerings from five to eleven.

Table 3. Entrepreneurship Center Student Enrollment

Course	1995-96	1996-97	1997-98	1998-99	1999-00
New Enterprises	70	107	270	180	161
Entrepreneurship Lab	20	60	138	150	174
Entrepreneurship Without Borders			70	55	55
Entrepreneurial Marketing				60	49
Technology Entrepreneurship				34	40
Entrepreneurs in the Internet					125
Entrepreneurial Finance					47
Independent Activities Period	128	170	283	418	369
All Others	70	180	165	146	66
Total	288	517	926	1043	1086

In fiscal year 2000, our faculty launched two new courses: Entrepreneurial Finance and Entrepreneurs in the Internet. In the coming year, our faculty will develop and teach three additional courses: Global Entrepreneurship Lab, an international version of the Entrepreneurship Lab, now in its fifth year; Business Plans that Raise Money; and Raising Early Stage Capital. In addition, we will continue to develop our executive education course Entrepreneurship Development Program (EDP).

Student organizations supported by and housed in the MIT Entrepreneurship Center achieved new heights this year. The MIT $50K Entrepreneurship Competition celebrated its 11th Anniversary with an epic 220 business plan entries and a new summer breakfast series for start-ups. In November, e-MIT launched the portal of choice for the New England entrepreneurial community. The e-MIT student organizers received the second annual Patrick J. McGovern, Jr. Prize, which is awarded each year to a student organization that works closely with the MIT Entrepreneurship Center and contributes most to the entrepreneurial spirit of MIT.

We expanded our efforts to build the alumni community in 1999–2000. In addition to the local monthly Entrepreneurship Society functions, the center hosted major networking galas in Silicon Valley and Manhattan. The events drew over 600 members of the center's network, including MIT and Sloan graduates engaged in entrepreneurial activity.

On the financial side, endowment pledges of support from entrepreneurial alumni since 1996 have provided $18 million in seed capital toward our goal of $60 million. Eleven corporate sponsors were selected in the upcoming year for their ability to add to our educational programs and assist our students and alumni in starting new technology ventures.

Kenneth P. Morse

MIT PROGRAM ON THE PHARMACEUTICAL INDUSTRY

The MIT Program on the Pharmaceutical Industry (POPI) was founded in 1991 as a research and education program for understanding the structure and dynamics of global pharmaceutical industry, the firms and their suppliers, customers and regulators.

Currently, more than 10 MIT faculty and 12 outside collaborators from other universities are participating in the research program. Since POPI's inception, some 30 MIT graduate students have completed doctoral work with support from POPI. More than 20 pharmaceutical, biotechnology or other healthcare firms have contributed funding and/or data for POPI's research or educational activities. As of June 30, 2000, 80 articles and working papers have reported on research conducted by POPI faculty and students.

In 1999–2000, faculty associated with POPI continued research on case histories of important drugs, the cost of new drug development, the use of new tools to systematize key aspects of drug discovery, pharmacoeconomics and many other topics.

In December 1999, POPI held its biennial symposium on the Future of the Pharmaceutical Industry. With more than 200 senior executives from industry and government in attendance, the Program launched a new research thrust with an examination of how science and technology are driving change in drug discovery, development, manufacturing and the business of pharmaceuticals. The Program has recently embarked on a major initiative that will examine how those changes are impacting the availability of new drugs and the delivery of health care.

Stan N. Finkelstein

SYSTEM DYNAMICS GROUP

The System Dynamics Group was founded by Professor Jay W. Forrester in the early 1960s to pursue research in the area of understanding the importance of structure in the behavior of complex systems, particularly corporate structure. Currently, we are studying three areas.

The National Model Project, a large computer model, strives for a better understanding of how the U.S. economy works, and is used to help analyze the effects of proposed economic policies. The Group uses the National Model to capture the interactions of local structures and decision-making policies, building a bridge that joins microstructure with macrobehavior. Corporations and private individuals fund this research which is directed by Professor Jay W. Forrester.

The System Dynamics in Education Project was established in 1990 with private funding. Writing the Road Maps series is the main area of activity. Road Maps is a self study guide for learning system dynamics which is available free at http://sysdyn.mit.edu. The series of self-study chapters use modeling exercises and selected literature to provide a way of learning about the principles of system dynamics and it's many uses. More recently, a distance learning course in system dynamics called The Guided Study Program has been offered using Road maps as the core text. This is a large UROP effort involving approximately ten students per term. The educational work of the System Dynamics in Education Project is headed by Professor Jay Forrester.

The Improvement Paradox: Designing Sustainable Quality Improvement Programs is directed by Professor John D. Sterman. With initial funding in the mid-90s from an NSF grant, the project studies the design of sustainable quality improvement programs. In the past, many firms abandon TQM programs due to lack of perceived impact on profitability, even after they experience a significant increase in performance. Through the development of formal models and original case histories, the Group seeks to identify the critical interactions between quality programs and a company's other organizational structures. A number of papers on this work are available from http://web.mit.edu/sdg/www/. Corporate sponsors have contributed additional support.

John D. Sterman, Nan Lux

ADMINISTRATION AND SERVICES

OFFICE OF ALUMNI AFFAIRS AND CORPORATE RELATIONS

Major Developments for the year:

- The Alumni Relations and Resource Development Offices were successfully merged into a larger and more efficient operation.
- About 530 alumni attended their class reunions, 33% more than the previous year.
- Sloan Alumni Relations hosted 2 Pre-Reunion events, 2 Summer Gatherings, and an alumni/student C-Function.
- A major Sloan Alumni Club conference in Boston on B2B e-commerce drew more than 300 people.

- The Dean addressed 14 different MIT and/or Sloan Alumni Clubs throughout the U.S. (6), Europe (3), Asia (3), and Latin America (2).
- The Dean had about 150 separate fundraising meetings with individual donors and corporate sponsors.
- The first Sloan Alumni Leadership Conference attracted about 20 representatives from 24 Sloan Alumni Clubs from around the world.
- The Dean's Advisory Council convened twice during fiscal year 2000 and has evolved into a very important vehicle to engage about 50 of the School's most significant alumni and friends in an advisory capacity.
- The Sloan Alumni Directory was published and sent to the School's 17,000 alumni. An Internet-based alumni *People Finder* is nearing completion and should help us build more effective networking.
- More than $85 million has been raised to support Sloan's priorities and projects in MIT's $1.5 billion capital campaign, with 4 full years remaining in the drive. Sloan needs to raise about $180 million to support the majority of the School's priority needs.
- Fiscal Year 2000 recorded more than $30 million in cash and more than $39 million in new pledges—a truly outstanding fundraising year.
- The Sloan Annual Fund raised more than $1.8 million in unrestricted funds, while an additional $522,000 supported the School's Minority Fellowship Program.
- The new Sloan Class Reunion Giving Program featured a record number of alumni volunteers (about 50) and raised about $3 million in cash and pledges.
- The Sloan Student Class Gift Program in its 5th year broke a new record raising $31,715 from 310 members of the class.
- OACR assisted Sloan's eBusiness Center in attracting $20 million in pledges and cash from corporate sponsors by marketing the Center to key alumni contacts.

During fiscal year 2000 Alumni Relations (AR) focused on identifying and capitalizing on opportunities to leverage and manage various projects, particularly class reunions, alumni club events, and speakers' series.

The general priorities of the AR group during the year were oriented toward the following:

- Updating and expanding OACR's use of multimedia to communicate with alumni constituencies.
- Addressing the office's technology needs to enhance the efficiency of delivering alumni services.
- Expanding and improving Reunion Class programs.
- Providing services to the 24 Sloan Alumni Clubs worldwide in support of membership, events, and speakers.
- Developing further the office's growing interaction with the Sloan MBA student senate and clubs.
- Enhancing the office's Mentor and Career Counseling programs.

During fiscal year 2000 the level of activity and number of programs and events managed by the AR group was very high. About 100 separate alumni events were held around the world with varying degrees of involvement and support from the AR group. The Dean addressed 14 MIT and/or Sloan Clubs around the world, while other senior Sloan faculty participated actively in many other MIT and Sloan Alumni Club events, including a *Pan Arab MIT Alumni Club Conference* in Cairo, and several *MIT On The Road* events in Boston, New York, and California.

More than 700 Sloan alumni served as volunteers in recruiting, MBA student mentoring, class reunions, and admissions. About 200 alumni took advantage of the Office's personalized career counseling services, and about 100 others spoke at the School during the year.

Reunion 2000 attracted a record of 530 people, a 33% increase over the preceding Reunion. Several very large alumni networking events were held—two in Northern California, two in New York, and one in Boston—on numerous themes, *e.g.* B2B, High Tech Entrepreneurship and Careers in Silicon Valley.

The growing use of the Internet for alumni networking and access to educational and research programs and events has made a significant impact during the year. Plans are underway to develop an *Alumni Learning Portal* which would serve as a web site for delivering lifelong learning and training materials to alumni. The initial focus of the *Alumni Learning Portal* will be on eBusiness content, but will then be expanded to include much broader content.

The hiring of a new Director of AR is a top priority for the next year, as is addressing staffing needs to provide more services to alumni clubs and expanding the use of technologies.

The Resource Development (RD) group has been focused on MIT's recently launched $1.5 billion capital campaign, in which Sloan is playing an important role. Sloan is concentrating on raising funds to support the construction of a new facility and to endow the Entrepreneurship Program. Sloan's collective priority funding needs are about $180 million.

The Sloan team has helped raise more than $85 million since the beginning of the counting period, *i.e.* July 1, 1997 or fiscal year 1998. This represents 47% of the $180 million goal, putting the School in an excellent position to reach its goal with four years remaining in the capital campaign. The proposed new Sloan Building and the Entrepreneurship Program are the School's top priority fundraising projects, compelling us to focus our efforts on raising 8-figure gifts from alumni. Several donors have collectively pledged about $30 million toward the cost of constructing the new building, $25 million of which was pledged by Bill Porter (SF1967) to name the building. About $12 million has been raised to support the Entrepreneurship Program thus far during the campaign. RD played an important role in helping the Sloan eBusiness Center attract about $20 million in cash and pledges from corporate sponsors by marketing the program to well-placed alumni in various companies around the world.

FY1998–FY2001 FUNDRAISING TRENDS

The investment made in recent years to expand the OACR has paid handsome dividends. From Fiscal Year 1998–Fiscal Year 2000 4.0 staff positions were added to the OACR while gifts and new pledges grew from $16 million to more than $85 million. If the School continues to carefully expand and more fully integrate external relations, it could raise as much as $25 million annually in the near future.

OACR plans to maintain the fundraising momentum created in recent years in parallel with MIT's $1.5 billion capital campaign. Sloan's internal campaign goal is to raise $180 million in seven years beginning in fiscal year 1998. This goal includes the estimated $55 million that the School would need to raise for the proposed new Sloan facility, and $25 million to support the School's Entrepreneurship Program. I am very optimistic that we will reach these goals, due to the recent success we have had in cultivating the School's Top 25 donor prospects, each of whom could make a gift of $5 million or greater.

For the first time since Alfred P. Sloan made a large personal gift to launch the Industrial Management Program at MIT in the early 1950s, a Sloan School alumnus has pledged $25 million to support the School. In addition, MIT's partnership with Merrill Lynch provides the Institute $20 million over five years, almost half of which will directly benefit the Sloan School's education and research programs in financial technology.

Fiscal Year 2000 cash receipts and written pledges make this truly a record year. More than $29 million in cash and more than $39 million in new pledges were recorded. The initial success of our efforts to build a Sloan Class Reunion Program has been modest, but will grow steadily. The RD group played a particularly active role in raising funds to establish four new chairs, and in generating about $2,300,000 in annual unrestricted support and minority fellowships in fiscal year 2000.

The amount of unrestricted funds that were raised between July 1, 1999 and June 30, 2000 grew by 96%, as compared to the same period the previous fiscal year. The breakdown of annual fund amounts follows.

Table 4. Sloan Annual Fund Report Fiscal Year 2000

Sloan Annual Fund	$587,392.34	
Dean's Fund for Innovation	$1,108,158.30	
Business Associates	$145,093.98	
Master's Minority Fellowships	$ 351,727.00	
PhD Minority Fellowships	$12,534.00	
Base Budget Income	$18,910.00	
New Endowment Monies	$23,000.00	
Growth of New Endowment Monies	$8,594.00	
Other	$104,590.50	
TOTAL	$2,360,000.00	+104%
	2641 donors	+15%

Notable Gifts and Pledges during Fiscal Year 2000:

New Sloan Facility

William A. Porter SF 1967: $25,000,000 pledge to name the facility
Rodolfo F. Barrera SM 1965: $2,000,000 pledge to name space
J. Spencer Standish 1945 SB: $1,500,000 pledge to name space
Judith C. Lewent SM 1972: $1,500,000 pledge to name space

Chairs / Fellowships / Scholarships Endowments
Siebel Systems: $2,600,000, MBA Fellowships
Luis R. Alvarez Renta SM 1974: $2,000,000 pledge, Chair
Joaquin E. Bacardi SM 1998: $2,000,000 pledge, Chair
Ching C. Chen SM 1965: $2,000,000, Chair
George & Sandi Schussel P SM 1994 & P 2000: $2,000,000, Chair
Fred Kayne SB 1960: $2,000,000 pledge, Chair
Sloan China Initiative
Jack C. Tang 1947 CH: $1,000,000
Sukanto Tanoto UN: $1,000,000
Educational and Research Programs
The E-Business Center attracted about 15 corporate sponsors who have collectively pledged about $20 million over the next three years to support the Center's educational and research programs
Arthur Andersen pledged $8 million to launch the *New Economy Value Research Laboratory* at the School.
Seven sponsors made gifts totaling $1,165,000 in support of the Sloan China Management Education project.
Merck Company Foundation: $600,000 to support the *Program on the Pharmaceutical Industry*
There were 6 gifts from companies and alumni in support of the Entrepreneurship Program, e.g. Eastman Chemical and Patrick McGovern 1959 LI.
Sloan Annual Fund
Jeffrey Shames SM 1983: $311,388
Peter Savitz SM 1982: $214,430
Martha Amram SM 1987: $127,419
Sloan Minority Fellowships
Jeffrey Shames SM 1983: $319,242

Ron Thomann

EDUCATIONAL SERVICES
Educational Services manages the infrastructure upon which Sloan's academic mission is carried out. The Education Services Office team prepares the space (facilities work), arranges for the players (faculty and course scheduling, student registration, student advising, program support), and manages information flow (internal communications, interface with MIT Registrar, grades, evaluations).

The office team oversees all registration issues for approximately 1100 Sloan students; manages the Web-based course prioritization system used by more than 2,000 MIT students, which equitably resolves difficult supply and demand issues in a department with increasingly popular classes and already high enrollments; handles scheduling of the nearly 200 class sections and recitations offered each term; maintains Sloan facilities; and produces both online and paper resource material for the School (including the PhotoBook, Directory, biocards, and weekly News@Sloan).

The Educational Services team focused this year on improvements to the registration process. A complete upgrade to the bidding system was necessary to meet Y2K compliancy, but was also a major step forward in serving students. The new system is even more customer-friendly and allowed us to add a new and much needed third round of bidding—the Wait List round. This option gives students far great access to wait lists, allowing them to bid over a several-week period. Bidding for wait lists, rather than a first-come first-served sign on, is a much more fair process, allowing us to better identify and meet real need. In addition, the resulting wait lists are more clearly prioritized for easier faculty use.

Support to the academic programs was strong on many fronts. An organizational restructuring set in place an MBA team, to better meet the needs of our largest group of constituents. A large effort was ongoing this year in behalf of the new MBA core. Educational Services team members were deeply involved in this process, from participation in core revision, to creating an entirely new schedule for all of Sloan's 200 fall courses, to assisting faculty in the process of course re-writes and new unit assignments. As in previous years, Educational Services continued to refine and analysis bidding data to assist Sloan's deans and faculty on issues of course and section offerings and teaching load plans.

Facilities management was a high priority. A prime initiative of the spring and summer was the design and construction of a new space in 3 Cambridge Center, which now houses a cluster of four of Sloan's research centers. This important effort provides much-needed space for the e-Business Center. Of equal importance is the new and

dynamic flow of knowledge between these centers, due to their co-location. In addition to this facility, which will house approximately 40 researchers and staff, Educational Services oversaw the renovation of space and moving of another 25 faculty and staff. As space grows tighter at Sloan, creative thinking and teamwork help us survive. Looking to the future, the Sloan New Building Committee is now fully operational, with the major involvement of our team.

Sloan enrollment remains high and Sloan classes continue to attract record numbers of MIT students from all departments. The School is working on creative ways to meet demand, including additional sections of classes in the evening, video sessions, and special seminars for the current students, as well as executive custom courses and new joint agreements with other MIT departments. The Educational Services staff faces daily challenges to maintain high levels of service to all. It is our role to balance precious resources such as classroom space and faculty teaching time across all programs. Finding new ways to track and analyze data is vital in this all-School effort.

Goals for 2000-2001 include completely revamping the class scheduling process, overhauling the teaching evaluation process, renovating the Sloan Lobby, enhancing current facilities even as we plan for those of the future and constantly improving customer service. We will continue to work with students to discover their changing needs and to find creative ways to meet them.

More information about this department can be found on the World Wide Web through the Students tab on the Sloan web site at http://mitsloan.mit.edu/.

Lucinda Hill

LEMELSON-MIT PROGRAM FOR INVENTION AND INNOVATION

The Lemelson-MIT Program is a nationwide educational initiative promoting invention and innovation through annual awards, an ongoing outreach campaign, and MIT courses that teach invention and entrepreneurship. Each year the Program presents inspirational role models in science, engineering, technology, and entrepreneurship through its $500,000 Lemelson-MIT Prize, $30,000 MIT Student Prize, High School Invention Apprenticeship, and Lifetime Achievement Award. This year the Program also partnered with a corporation (Siemens' Unisphere Solutions, Inc.) to present a special $30,000 Student Team Prize for innovativeness in telecommunications and networking technologies. The Program's goal is to encourage young people to pursue careers in these areas as well as to raise public awareness of the critical role inventor-innovators play in society.

Winners of the 2000 Lemelson-MIT Awards are vascular surgery innovator, entrepreneur and Stanford University professor Thomas Fogarty (Prize); engineer, product designer and Mechanical Engineering graduate Amy Smith (Student Prize); recent high school graduate and inventor Charles Johnson (Invention Apprenticeship); wireless pioneer and inventor of the walkie-talkie Al Gross (Lifetime Achievement Award); and Electrical Engineering graduate students Michael Lim, Thomas Murphy and M. Jalal Khan (Student Team Prize).

In addition to a half-hour CNNfn "Business Unusual" show dedicated to the Lemelson-MIT Program and its Award winners, the Program presented exciting inventor-innovator role models through several broadcast and print features, including TV segments on the 2000 and 1999 high school winners of the Invention Apprenticeship on CNNfn and Oprah Winfrey's Oxygen Media, and profiles in *Popular Science, Forbes, New York Times, Business Week, Time Magazine, The Financial Times, Chicago Tribune, Boston Globe* and the *Boston Business Journal.* The Program also conducted joint outreach programs with the Smithsonian's National Museum of American History and the MIT Museum, and participated in the MIT Media Lab's first "MindFest" event.

Through funding to courses in the schools of Engineering and Sloan, the Program helped stimulate the creation of new inventions in a team-based environment at both the undergraduate and graduate levels (2.009 Product Engineering Process and 2.783J Product Design and Development), as well as helped encourage entrepreneurial student talent through the Center for Entrepreneurship's internship program (15.399 Entrepreneurship Lab). Selected student teams from 2.009 presented their prototypes in Washington, DC at the National Museum of American History as well as in New York City at the American Museum of Natural History.

New projects in 2001 include a book on American inventor-innovators to be published with the MIT Press, a special hands-on exhibit at the MIT Museum titled "Thinkapalooza" and a presentation by Lemelson-MIT Prize winner Dr. Thomas Fogarty at the Edgerton Center. For more information on the Lemelson-MIT Program, please visit the "Invention Dimension" at http://web.mit.edu/invent/.

Annemarie Amparo

SLOAN COMMUNICATION OFFICE

The Sloan Communication Office develops and implements innovative, multimedia approaches to market Sloan as a world-class business school. The four-person staff designs and executes a global media strategy, coordinates and manages Sloan's Web presence, provides communication support for the Dean's Office, publishes a magazine for alumni and other constituencies, and develops and produces Sloan's marketing collateral.

Communication activity at Sloan continued to increase in fiscal year 2000 and is expected to grow further in fiscal year 2001. The added load involves ongoing management and development of the Web, increased media coverage, regular publication of *ROI* magazine, increased support for the dean (especially with international visits to alumni and the media), support for the capital campaign and increased coordination with resource development, alumni relations, and technology services.

Media coverage, which increased sixfold in the previous year again doubled this year, with the number of queries alone increasing by nearly 40%. Major events and announcements (i.e., the William Porter donation and the launch of the capital campaign), the dean's continued media tour, and the increased visibility of the Entrepreneurship Center and the Center for eBusiness at MIT contributed to this increase.

The number of news releases distributed by the office continued to rise over the past year, particularly with the publicity of an increasing number of student-run events. The MIT $50K Entrepreneurship Competition and the Sloan eBusiness Awards in particular garnered a great deal of media attention.

Growth of the Internet is also pushing up media relations demands. Nearly 25% of Sloan's media work (a percentage that is increasing) now involves working with Web-based media.

Fiscal year 2000 was the first full year of the new Sloan web site launched in February 1999. The Communications Office regularly updates the features on the section fronts and manages a much higher level of service and information demand from all constituencies. The site has won awards for its innovative architecture and feature format from CASE, Web Marketing Association, and Massachusetts Interactive Media Council and is now touted as a leading web site for business schools.

The alumni magazine, MIT Sloan *ROI*, was redesigned and three issues were published to very good feedback from alumni and other constituencies. The print version is now supported by an online *ROI*, with periodic electronic newsletters alerting alumni to the content of the latest issue.

The Faculty Expertise Guide was redesigned and published with supporting faculty profiles on the web site. The careful thought put into developing the infrastructure and people date base now makes it possible for faculty to easily update their profiles. It also gives the Communications Office—and the rest of the community—access to the most updated information.

Ranking business schools is a lucrative and growing industry. As a result, more and more publications and other rating agencies are conducting surveys —more than double in the last year. Responding to the 20 or more major surveys requires coordination with various offices throughout the School. *Financial Times* added two major surveys this year. *Business Week* conducts two surveys that are now updated annually on the Web. *US News and World Report* is adding a second major survey on undergraduate management education. The *US News and World Report* survey alone required input from at least six program offices.

The overall goal for fiscal year 2001 is to continue to manage the increasing global coverage of Sloan and its activities and ensure that the school's key messages are well represented. With the dean's visibility and his visits worldwide along with the capital campaign, we expect media coverage to at least double again this coming year.

SLOAN TECHNOLOGY SERVICES

Sloan Technology Services (STS) supports the computing needs of faculty, staff and students at the Sloan School. It is dedicated to the support of research, teaching and the best uses of information technology. STS undertook a number of initiatives during fiscal year 2000.

STS staff successfully "touched" 300+ computers and provided remediation assistance for another 100+ computers as part of the Year2000 effort. Also installed Year2000 patches and compliant software on approximately fifteen (15) servers.

STS established the Student Computing Advisory Committee to identify student computing priorities. Based on student priorities, STS installed web-based calendar software for MBA program and installed Windows NT file server with 50MB space allocation per student.

STS provided support to 67 courses during Fall 1999 and 78 during Spring 2000. Developed an interactive web-based trading simulation. The application was used by all students in the core Finance course.

STS acquired and installed the following WRDS access for financial data analysis; a Windows version of the SAS package on faculty desktops; and X- Windows software for remote host access. In addition, STS added several new COMPUSTAT databases to core research dataset library.

STS developed significant new functionality in the Sloan "People" database. Alumni can now update their profiles in "real time" and perform enhanced searches. In partnership with MIT Audio-Visual Services, STS installed state-of-the-art computer projection capability in E52-175.

Plans for fiscal year 2001 include:

- SloanSpace: Develop student information portal, including support for web-based course management.
- Wireless Network: Install high-speed wireless network.
- Alumni Database: Synchronize Sloan Alumni database with MIT ANS database.
- Web Infrastructure: Upgrade web hardware and infrastructure.
- Help Desk: Acquire and Install Help Desk software for tracking service calls.
- Ecommerce: Incorporate eCommerce capability in web site for Sloan Management Review and other Sloan units.
- Security: Harden Sloan servers and establish stronger security regimen.
- Business Recovery Planning: Develop Business Recovery Plan, identifying key services and our mode of response in case of business interruption.
- Educational Technology: Continue to develop platform and programs in educational technology and executive education.
- Research Computing: Upgrade research computing server and research computing lab.
- Student Computing: Upgrade student computing labs as part of annual upgrade cycle.

Alfred Essa

SLOAN MANAGEMENT REVIEW

Sloan Management Review (SMR) is a peer-reviewed journal that disseminates research from the top business schools, with the dual purpose of affecting management practice and publicizing the Sloan School. Fiscal Year 2000 was a very successful year for *SMR* in terms of revenues, profits, circulation, and citation levels.

The journal finished the year with revenues of $3 million and profits of $1 million. *SMR's* circulation exceeded 35,000, readership grew to 100,000, renewal rates topped 55%, and reprints and permissions sales were at all-time highs.

SMR's citation and impact ratings, as measured by the Social Science Citation Index, were also impressive. It ranked fourth among the management journals tracked.

Seventy-five percent of articles came from top-20 business schools, including several from MIT faculty. Well-known authors include Sumantra Ghoshal, Christopher Bartlett, Henry Mintzberg, C.K. Prahalad, Kathleen Eisenhardt, Richard T. Pascale, Constantinos Markides, Arnaldo Hax, John Quelch, and J.B. Quinn.

SMR has hired a new editor-in-chief and is implementing an aggressive growth and redesign strategy during fiscal year 2001. We expect to increase circulation to over 53,000 subscribers, improve *SMR's* web offerings, and significantly increase advertising, permissions, and reprints revenues.

Susan Petri

DEAN, SCHOOL OF SCIENCE

The School of Science at MIT continues to play a leadership role, both nationally and internationally, in science education and research. Our graduate education programs are ranked among the very top in all the disciplines of the School by a variety of organizations. Maintaining that high standard is the highest priority of the faculty and administration in the School.

The School of Science continues to do a major part of the undergraduate education at MIT. Biology has grown in the last decade to become the second largest major (after EECS) at the Institute. In addition, the Departments of Mathematics, Physics, and Chemistry have some of the largest student contact hours. This overall excellence of teaching is exemplified by the number of Macvicar Fellows in the School (43% of the total). In 1999, Professor Chris Kaiser of Biology was selected as a new Macvicar Fellow, and in 2000, Professor John Belcher (Physics) and Professor Steven Pinker (BCS) were chosen as Macvicar Fellows. The School of Science Teaching Prize for Undergraduate Education for 1998–99 was awarded to Professor Alan Guth of Physics. There was no award made for graduate teaching that year. In 1999–2000, the undergraduate teaching prize was awarded jointly to Professor Tania Baker of Biology and Professor Greg Fu of Chemistry. The graduate teaching award for 1999–2000 was awarded jointly to Professor Ann Graybiel of Brain and Cognitive Sciences and Professor Mriganka Sur, also of BCS.

The quality of an academic unit such as the School of Science is determined by the caliber of the faculty involved. One of the highest priorities of the School administration is to support our existing outstanding faculty and to recruit to MIT exceptionally talented young researchers and educators, especially underrepresented minorities and women, to our faculty. In 1998–99, twelve new faculty joined the School as Assistant Professors, including three female and four underrepresented minority Assistant Professors. Our faculty received many honors and awards during the past year, both external and internal. Of particular note is the awarding of Howard Hughes Medical Investigator status to three of our young faculty: Professor Sebastian Seung (BCS), Professor Angelika Amon (Biology and CCR) and Professor Steven Bell (Biology).

The many new research initiatives and fundamental discoveries that occurred in the various departments and laboratories of the School of Science are discussed below in the reports of those units.

Fund raising in the School of Science reached all time highs over the past few years with a total received exceeding $30 Million in fiscal 1999.

ACADEMIC PROGRAMS

There were 822 undergraduate majors in the School of Science during the past academic year, a 2.1% increase from the previous year. The number of minority student majors at the undergraduate level changed as follows:

Blacks	41 to 35 (15% decrease)
Hispanics	62 to 67 (8% increase)
Native Americans	6 to 9 (50% increase)
Asian Americans	239 to 234 (2% decrease)

The number of minors in the School of Science in 1998–99 were 137, a decrease of 17 percent from a total of 161 last year. The female undergraduate population decreased marginally from 429 to 318. 25 percent of the Institute's upperclass undergraduates were enrolled in the School of Science.

Graduate enrollments in science decreased from 990 to 955. The total enrollment represents 18 percent of the graduate population at MIT. The number of minority students at the graduate level changed as follows:

Blacks	17 to 15 (12% decrease)
Hispanics	23 to 18 (22% decrease)
Native Americans	2 to 2
Asian Americans	50 to 48 (4% decrease)

The number of female graduate students decreased from 292 to 285 (-2.4%). However, the overall percentage of female graduate students remained at 30%.

The 260 faculty members in the School this past year represents a 0.8% increase from the previous year. The undergraduate student-to-faculty ratio was 3.1 to 1, and the graduate student-to-faculty ratio was 3.7 to 1.

RESEARCH VOLUME

The FY99 research volume was $117 million, a slight decrease over the FY98 research volume. This figure does not include the significantly increased research volume by MIT faculty at the Whitehead Institute (>$30 million), HHMI faculty (>$10 million) as well as the research volume associated with School of Science research carried out in the interdisciplinary laboratories reporting to the Vice President for Research.

Robert J. Silbey

DEPARTMENT OF BIOLOGY

The Biology Department has 63 active faculty members: 15 are located in the Whitehead Institute, 12 are located in the Center for Cancer Research, four are joint appointees with the Department of Brain and Cognitive Sciences, one is joint with Chemistry, and one is joint with the Department of Civil and Environmental Engineering. Two faculty members also hold two-key appointments in the Division of Bioengineering and Environmental Health. Including active emeritus faculty, the Department includes three Nobel laureates, 21 members of the National Academy of Sciences, and 10 investigators of the Howard Hughes Medical Institute. The department has a stellar international reputation in research and teaching and has been a leading contributor to the development and application of molecular and cellular biology.

EDUCATIONAL ACTIVITIES

In the past year, 333 undergraduates registered as Biology majors, the third largest number of majors following Electrical Engineering and Mechanical Engineering. The Bachelor of Sciences in Biology degree was awarded to 131 students this past year: 112 in the regular Course VII Program and 19 in the VII-A Program.

A number of Biology majors received awards in 1999–2000. Marie P. Shieh and Jesse S. Boehm received the John L. Asinari Award in recognition of outstanding undergraduate research in the field of life sciences. Carly R. Klein was the recipient of the Salvador E. Luria Prize, honoring outstanding scholarship and research of publication quality. The Whitehead Undergraduate Prize, given to an undergraduate majoring in Biology who shows outstanding promise for a career in biological research, was awarded to Shivkumar Venkatasubrahmanyam. Lucy Q. Shen received the Ned Holt Prize for excellence in scholarship and service to the MIT community. Lucy also received the Association of MIT Alumnae (AMITA) Senior Academic Award, given to senior women who have demonstrated the highest level of academic excellence through coursework and related professional activities at MIT. Sam Jahanmir received the William L. Stewart Jr. Award, which recognizes contributions by an individual student or student organization to extracurricular activities and events during the preceding year. Jennifer A. Frank was one of the recipients of the Karl Taylor Compton Prize, which is the highest award presented by the Institute to students and student organizations in recognition of achievements in citizenship, devotion to the welfare of MIT, and outstanding contributions to the MIT community. Cynthia Reinhart received the Randolph G. Wei UROP Award, given each spring to an undergraduate who has made the most outstanding contribution in undergraduate research at the interface of the life sciences and engineering. Hilarie C. Tomasiewicz won the Robert A. Boit Writing Prize in the poetry category. Kris Schnee and Jennifer Son were awarded second and third place, respectively, in the short-story category. Two Biology seniors—Sarah R. Cohen and Marketa Valeterova— received Theater Awards for their roles in Shakespear's Ensemble's. The following biology majors were elected to Phi Beta Kappa: Danielle Adams, William BeeBee,William Chen, Paul Crowley, Elizabeth Demicco, Nicholas Ingolia, Madhulika Jain, Anupam Jena, Carly Klein, Spencer Liang, James Kang, Amy Lee, Lia-Christina Rodriguez, Lucy Shen, and Shivkumar Venkatasubrahmanyam

From July 1, 1999 to June 30, 2000, 29 Ph.D. degrees were awarded in the department, and 5 Ph.D. degrees were awarded in the Joint Program in Biological Oceanography with the Woods Hole Oceanographic Institute (WHOI). The maximum number of Ph.D. candidates registered in the Department in 1999–2000 was 212, with another 34 in the Joint Program. The entering class in 1999, including 4 in the Joint Program, was 47. The class arriving this coming Fall will be 44 students, with an additional 8 students in the Joint Program. This was the second year that laboratory rotations were introduced into the first year graduate curriculum, and they continued to be highly successful.

RESEARCH

The research activities of the department cover most areas of modern biology, including biochemistry, genetics, microbiology, cancer biology, cell and developmental biology, immunology, neurobiology, virology, and structural biology. The research achievements over the last year are too numerous to be listed here. There were, however, several significant advances in the areas of human health and disease. The Guarente lab reported that a gene known to govern the rate of aging in yeast cells is also active in mice, yielding new insights into why mice and people age and into possible ways of enhancing life span. They discovered that an anti-aging gene in yeast is an enzyme which can turn off whole sections of the genome, slowing the organism's aging process. Scientists in the Kim laboratory discovered a new candidate drug for treating HIV infection, a class of compounds that prevent HIV infection by stopping the virus at its port of entry into the cell. Scientists in the Lodish lab and colleagues at Millennium

Pharmaceuticals identified a protein in the small intestine that plays a key role in the uptake of dietary fat, which may constitute a novel target for anti-obesity therapy in humans. Researchers in the Walker lab found a similar genetic culprit behind chronic infection of plants and mammals. This information could potentially lead to a vaccine for human brucellosis, a debilitating disease also known as undulant fever. Scientists in the Young lab identified a protein fragment that is exceptionally potent in eliciting an immune response against infected cells and cancer cells, which could lead to potential vaccine for immunocompromised patients. The Weinberg lab showed how normal human cells could be converted into cancer cells, a transformation that hitherto had not been achieved. They were able to create human tumor cells of a defined genetic make-up and determine with precision the repertoire of genes and signaling pathways that are required in concert to program malignant proliferation. Using genetically engineered mice, the Rosenberg Lab developed a new model of how heart attacks and strokes occur in humans. Over the next few years, this new model should allow the researchers to pinpoint the genetic basis of heart attacks and strokes, and to suggest improved forms of therapy.

PERSONNEL

Professor Tyler Jacks was promoted to Full Professor, effective July 1, 2000. Professor Stephen Bell was promoted to Associate Professor with tenure and Professor David Bartel was promoted to Associate Professor (without tenure).

We are pleased to report that Michael Yaffe and Luk Van Parijs have accepted faculty positions in the department. Both will join the Center for Cancer Research and the department as Assistant Professors in the Fall.

Three new faculty members, Jamie Cate, Troy Littleton and Martha Constantine-Paton, arrived during the past year to set up their laboratories. Professor Cate, a structural biologist, joined the Whitehead Institute and the department as an Assistant Professor; Professor Littleton, a neurobiologist, joined the Center for Learning and Memory and the department as an Assistant Professor and Professor Constantine-Paton, a neurobiologist, joined the department as a Full Professor.

Honors and Awards

Tania Baker won the 1999–2000 School of Science Undergraduate Teaching Prize. Jamie Cate received a Searle Scholar Award. Arnold Demain received a Doctor Honoris Causa from Michigan State University and was elected to the Board of Governors of the American Academy of Microbiology. Gerald Fink received an honorary Doctor of Science from Cold Spring Harbor Laboratory. H. Robert Horvitz received the March of Dimes Prize in Developmental Biology. Nancy Hopkins was elected to the Institute of Medicine. Rudolf Jaenisch was named to the Board of Trustees at Cold Spring Harbor Laboratory. Peter Kim was elected as a Fellow of the American Association for the Advancement of Science and was the recipient of the Moosa Award from the Biochemical Society of Korea. Eric Lander received an honorary doctorate from Tel Aviv University, and received the Beckman Prize from the American Association of Lab Automation. Boris Magasanik received the 2000 Abbott-ASM Lifetime Achievement Award. Terry Orr-Weaver was elected to the Board of Directors of the Genetics Society of America. Alexander Rich received the 2000 Bower Award for Achievement in Science from the Franklin Institute of Philadelphia. Graham Walker received the Arthur C. Smith Award from MIT. Robert Weinberg received the Albert Einstein World Award of Sciences from the World Cultural Council, the Ernst Bertner Memorial Award from the MD Anderson Cancer Center, and the City of Medicine Award.

Dr. Richard Klausner, Director of the National Cancer Institute, gave a keynote lecture on cancer research as part of the events celebrating the naming of the biology building in honor of David H. Koch. Koch has pledged $25 million to support cancer research at the Institute. The first two Koch graduate fellows were named last year.

More information about the Biology Department can be found on the World Wide Web at http://web.mit.edu/biology/www/.

Robert T. Sauer

DEPARTMENT OF BRAIN AND COGNITIVE SCIENCES

The human brain is the most complex, sophisticated, and powerful information-processing device known. To study its complexities, the Department of Brain and Cognitive Sciences at the Massachusetts Institute of Technology combines the experimental technologies of neurobiology, neuroscience, and psychology, with the theoretical power of computational neuroscience and cognitive science.

FACULTY RESEARCH DEVELOPMENTS

Brain Mechanisms of Vision

Edward Adelson's lab is continuing its research on the perception of lightness and transparency. They have developed a new understanding of the interaction of statistical and configural constraints in the human visual system's analysis of surface color. In addition, they have started a new project on the perception of material properties, such as shininess or roughness. Unlike object recognition, few have looked at the perception of materials. Since this is an important topic for machine vision as well as human vision, they are devising machine vision algorithms that will allow material recognition.

A primary focus in Bart Anderson's lab is stereopsis. Many of the cells that exhibit disparity tuning in V1, MT and MST are also tuned to the direction and speed of a stimulus, as well as to its orientation content. They have developed a method that has generated the first psychophysical findings that demonstrate the role of motion and orientation in stereoscopic matching. These results suggest that one of the functional roles of cortical cells that multiplex the stimulus dimensions of speed, motion direction, and contour orientation is to help solve the binocular matching problem.

Nancy Kanwisher's lab has developed a new "event-related fMRI adaptation" technique that allows the characterization of neural representations in discrete visual cortical regions. Her lab has also recently discovered the strongest neural evidence yet for object-based visual attention.

Research in Peter Schiller's lab investigates the neural control of vision and eye movement using physiological and behavioral methods. Recent work on vision concentrates on the neural mechanisms of depth perception, particularly stereopsis and motion parallax, but studying neuronal properties in the visual cortex of rhesus monkeys. Work on eye movement control examines how saccadic eye movements are produced by the numerous cortical areas involved that reside in the occipital, parietal and frontal cortices.

Since starting at MIT in September, 1999, Pawan Sinha has set up his laboratory for research in high-level vision. He seeks to understand the computational principles underlying the brain's ability to recognize objects, scenes and sequences. His approach involves examining human recognition performance with highly impoverished images. Computational analyses of these 'simplified' stimuli provide valuable clues about the nature of information the brain uses for visual pattern recognition.

Learning and Memory

Emilio Bizzi's lab seeks to understand motor control and motor learning. With respect to motor learning, they have described the neural changes observed in the primary motor cortex, the pre-motor cortex and the supplementary motor areas in monkeys while they learn a new motor skill. In all these areas they found a sizable population of cells that changed their tuning properties. During learning, these cells took on the properties of neurons that are involved in the control of movement.

Ann Graybiel's lab studies brain mechanisms related to how we acquire habits. In one study reported in the past year, they recorded the activity of neurons in the basal ganglia while rats learned how to navigate a T-maze in order to receive chocolate rewards at the end of the maze. As the animals learned how to carry out this procedural task or "habit," there were large-scale changes in the activity patterns of neurons in the basal ganglia. These changes were long lasting, suggesting that circuits involving the basal ganglia have their activity rewired as a consequence of learning.

In a second study, the lab studied brain changes that occur in rats exposed to repeated doses of drugs such as amphetamine and cocaine, which lead to addiction and drug-dependent habits. The researchers found that this treatment induced highly distinctive changes in the patterns of expression of early response genes in the basal ganglia. There was a very high correlation between these changes in pattern and the changes in behavior exhibited by the animals.

Earl Miller's lab found a neural correlate of the concepts "match" and "nonmatch" in monkeys that could apply them to any image. They also found prefrontal neurons that conveyed which of 3 complex rules a monkey was

currently using. Finally, they discovered a neural correlate of perceptual learning. After 5 days practice with a set of objects, monkeys were better at recognizing them when they were degraded with noise. Practice also resulted in fewer neurons being activated in their prefrontal cortices, but these neurons communicated more information and were better at discriminating the degraded objects compared to when they were novel.

At CBCL, Tomaso Poggio's group continues to work on the problem of learning in a) theory; b) engineering applications; c) neuroscience. In the theory domain, they are extending a mathematical framework for statistical learning. They are applying learning techniques to bioinformatics (DNA chips data), to information extraction from multimedia data, to financial markets, to trainable man-machines interfaces and to computer vision for object detection. In the neurosciences, they have continued to work on models of cortical circuitry underlying object recognition and object categorization and begun collaborations to test experimentally its predictions, including one with Earl Miller on object categorization in prefrontal cortex.

Molly Potter's lab continued three lines of research and initiated one new line: short-term memory for naturalistic pictures, showing that the immediate representation is of gist, not just visual features; competition for attention between two near-simultaneous written words, showing intense competition over at least 500 ms; immediate visual memory for visual colors, shapes, and orientations; and interaction between pictured objects and words in rapidly presented sequences.

Through functional brain imaging, Anthony Wagner's lab examines how human memory is organized and supported by the mind and brain. Over the past year, they have explored the executive control of memory—that is, how attention mechanisms subserved by the frontal lobes interact with other brain structures to guide memory formation and retrieval. Recent advances include characterization of multiple frontal-temporal neural circuits that support memory formation, and delineation of the functional organization of the frontal lobes.

Research in Matt Wilson's lab addresses the question of how memories are formed and maintained within the mammalian nervous system. Of particular interest is the possible role of sleep in the long-term establishment of memory. By studying the interactions between brain areas using simultaneous neural recording techniques, they are pursuing the flow of mnemonic information during awake and sleep states between brain areas involved in memory formation and areas involved in higher-level cognition and decision making. They have recently found direct evidence of dreaming in rodents by identifying the reactivation during REM sleep of memory patterns established during recent awake experience.

Brain Development and Plasticity

Guosong Liu's lab studies the mechanisms that control the levels of NMDA receptor activation at single synapses. This is a critical issue for the understanding of molecular mechanisms of synaptic plasticity. They found that the levels of NMDA receptor activation during synaptic transmission are determined by the concentration of transmitters in the synaptic cleft and can be enhanced by genetic modification of the NMDA gene. These findings shed new light on the mechanisms controlling NMDA receptor activation during synaptic transmission.

At the cellular level little is known about mechanisms underlying activity-evoked synaptic remodeling during visual system development. In Elly Nedivi's lab, screening a pool of candidate plasticity genes (cpgs) that they previously identified revealed a subset that are expressed in the developing visual cortex and are activated by light, suggesting they may be involved in activity-dependent aspects of visual system development as well as everyday efficient function. They are now using cpgs as molecular tools to probe activity-dependent plasticity in the visual system.

Mriganka Sur's lab demonstrated principles underlying plasticity of circuitry in the developing and mature cortex. By routing visual projections to the auditory thalamus and cortex in developing animals, they showed that the auditory cortex could develop local and long-range networks that were typical of the visual cortex. By probing the function of visual cortex networks underlying orientation tuning in adult animals, they showed that these networks undergo profound plasticity as a consequence of responses to previous stimuli.

Richard Wurtman's lab discovered that Nerve Growth Factor causes parallel increases in both the phospholipids and the transmembrane protein APP in membranes. (APP is involved in Alzheimer's Disease, but probably is also involved in neurite outgrowth). Moreover, exposing cells to the membrane precursors choline and cytidine also increases the secretion of the neurite-expanding fragment of APP, i.e., "soluble APP."

Language and Number Systems of the Brain

Research in Ted Gibson's language comprehension lab has demonstrated that reading times in English sentences are strongly affected by the distance between key words in the sentence structure (e.g., a subject noun and its verb that

depend on each other for interpretation). This work has important implications for understanding what makes language easy or difficult to understand.

With Stan Dehaene, Elizabeth Spelke's lab explored two systems of representation that underlie adults' numerical reasoning. Combined behavioral and neuroimaging techniques provide evidence that reasoning about exact numerosities depends in part on a frontal brain system tied to language and verbal memory, whereas reasoning about approximate numerosities depends in part on a parietal brain system tied to spatial memory.

PERSONNEL CHANGES AND NEW PROGRAMS

Edward Gibson was granted tenure and Barton Anderson was promoted to Associate Professor without tenure. In the last year, the department began several new initiatives including a weekly colloquium series. An international group of distinguished speakers were featured. In addition, two Hans-Lukas Memorial lectures and Margaret Roche Donlan Bidwell lecture were held. For the first time, the department hosted an event at the annual Society for Neuroscience Meeting. The response was overwhelmingly positive and will take place again next year.

EDUCATION

Ten new graduate students enrolled in the Fall 1999. One had received and NSF Fellowship, two were supported by fellowships made possible by a generous grant from Walter A. Rosenblith, and the remainder were funded by department NIH training grants. Of our six students receiving Ph.D.s, four were recipients of postdoctoral fellowships, one has a faculty appointment at the University of Illinois, Urbana-Champaign, and the sixth is working on manuscripts with her former advisor. Two new or completely revised graduate courses are Human Memory and Learning, taught by Anthony Wagner, and Introduction to Neural Networks, taught by Sebastian Seung.

Of the 93 undergraduate students enrolled in the program, 22 were graduating seniors. The curriculum was reviewed by an ad hoc education committee and will be streamlined this year by reducing the four tracks to two areas of specialization: Systems and Computational Neuroscience, and Cognitive Science. In addition, the same core subjects will be require for all majors and a greater variety of other courses will be available. New courses to be offered include: Introduction to Computational Neuroscience (Sebastian Seung), Foundations of Human Learning and Memory (Anthony Wagner), Cognitive and Behavioral Genetics (Elly Nedivi with Steve Pinker and David Housman), and Object and Face Recognition (Pawan Sinha). The later two will meet with graduate sections as well.

FACULTY HONORS AND AWARDS

Ann Graybiel	Named Head of the Board of Neuroscience and Behavioral Health of the Institute of Medicine Scientific Advisory Board of the Max Planck Institute for Biological Cybernetics MIT Teaching Prize for Excellence in Graduate Education by the School of Science
Earl Miller	Troland Research Award from the National Academy of Sciences
Elly Nedivi	Fred and Carole Middleton Career Development Chair
Steven Pinker	MIT MacVicar Faculty Fellow for 2000 for devotion to undergraduate education Peter de Florez Professor of Psychology His book, The Language Instinct, was named one of the 100 best science books of the century by American Scientist magazine.
Tomaso Poggio	Laurea Honoris Causa from the University of Pavia for Volta's Bicentennial
Sebastian Seung	Howard Hughes Medical Institute Assistant Investigator Robert A. Swanson Career Development Professorship in the Life Sciences McKnight Scholars Award
Pawan Sinha	Alfred P. Sloan Research Fellow for 2000 NEC Award for 2000–01 Award from the Defense Advanced Research Projects Agency for 2000–02.
Elizabeth Spelke	American Psychological Association's Distinguished Scientific Contribution Award American Psychological Society's William James Prize for Scientific Contributions

Mriganka Sur	MIT Teaching Prize for Excellence in Graduate Education by the School of Science Australian Neuroscience Society Distinguished Lecturer for 2000 Sigma Xi Distinguished Lecturer for 2001–2003
Anthony Wagner	Surdna Foundation Research Award, 2000 Ellison Medical Foundation New Scholars Award, 2000

More information about the Department of Brain and Cognitive Sciences can be found on the World Wide Web at http://web-bcs.mit.edu/.

Mriganka Sur

DEPARTMENT OF CHEMISTRY

In the 1999–2000 academic year, the Chemistry Department continued its strong program in research and undergraduate and graduate education. Associated with the department currently are 200 graduate students, 114 postdoctoral researchers, and 102 undergraduate chemistry majors.

As of July 1, 2000, the Chemistry Department Faculty comprises full-time faculty members including 6 Assistant, 2 Associate, and 21 Full Professors including one Institute Professor and four TBA slots, one of which will be filled by Joseph Sadighi who joins the Department as an Assistant Professor on July 1, 2001. Harald Schwalbe joined the Department as an Assistant Professor on October 20, 1999. Professor Satoru Masamune retired on December 31, 1999. Professor Robert J. Silbey was selected to be the Interim Dean of Science, effective February 1, 2000.

FACULTY AWARDS AND HONORS

Professor Robert W. Field was selected Haslam & Dewey Professor of Chemistry.
Professor Dan Kemp received the ACS Ralph F. Hirschmann Award in Peptide Chemistry.
Professor Alan Davison was elected as a Fellow to the Royal Society of Chemistry.
Professor Cathy Drennan received the Surdna Foundation Research Award and also
the Cecil and Ida Green Career Development Chair.
Professor John Essigmann was awarded the honorary Mutation Research Award for Scientific Excellence by the American Chemical Society.
Professor Greg Fu received the School of Science Undergraduate Teaching Prize and the Chan Memorial Award in Organic Chemistry.
Professor Frederick D. Greene was awarded the distinction of Fellow by the American Association for the Advancement of Science.
Professor Jeff Steinfeld received the 1999 Director's Award for Advancing ACS Public Policy in Environment. Professor Steinfeld was also named as the Chair of the American Chemical Society's Committee on Environmental Improvement. The Committee's mission is to coordinate the American Chemical Society's agenda for sustainability and to act as the ACS's voice on environmental issues.
Professor Jianshu Cao was selected as one of the recipients of the Solomon Buchsbaum AT&T Research Fund and was also awarded the Young Researcher Award in Japan for his paper entitled "Quantum Coherence in Nonlinear Optical Professes: Theory and Possible Application to Control of Chemical Reaction and Quantum Computation."
Professors Kit Cummins and Peter Seeberger were chosen by Technology Review Magazine as two of the TR100 Young Innovators at a ceremony honoring 100 creative young people who will make significant contributions to information technology, biotechnology and materials science.
Professor Mario Molina was awarded the United Nations Environment Programme (UNEP) Sasakawa Environment Prize.
Professor Harald J. Schwalbe was awarded the Karl-Winnacker-Stipend, a five-year Hoechst AG sponsored award.
Professor Steve Buchwald received the ACS Award in Organometallic Chemistry.
and was also elected to the American Academy of Arts and Sciences.
Professor Tim Swager received the ACS Arthur C. Cope Scholar Award.

INFRASTRUCTURE DEVELOPMENTS

The MIT Chemistry 2000 campaign, helping to finance the renovation of 90,000 square feet of laboratory space, is now complete more than a year ahead of schedule. Generous gifts and pledges from department alumni/ae have brought us to our $4 million external funding goal. These campaign resources (including a challenge grant from Visiting Committee Chair Richard Simmons), combined with department and Institute commitments, have enabled $20 million of reconstruction in buildings 2, 4, and 6. A $44 million renovation of building 18, approved by the central administration, and construction has begun in the summer of 2000. We summarize below the progress made in the main group, buildings 2, 4 and 6.

Completed in prior years were renovations to space housing the Chemistry Education Office on the 2nd floor of building 2, Professor Nocera's wet labs on the 2nd and 3rd floors of building 2, Laser labs for Professor Bawendi in the basement of building 18, the Department of Chemistry Instrumentation Facility (DCIF) in the sub-basement of building 18, the first half of Professor Ceyer's labs on the 1st floor of building 6, the departmental X-ray laboratory on the 3rd floor of building 2 and the contraction and relocation of the departmental machine shop to make way for the renovations of the laser labs in the basement of building 6.

Renovations in the basement of building 2 and 6 creating Laser labs for the Field, Nocera, Nelson and Tokmakoff groups were completed in early 2000 and these groups have moved into these new labs from their temporary locations in the Francis Bitter Magnet Lab and the Steinfeld lab. Renovations of the Steinfeld lab in building 2 are underway and will completed this summer. The Steinfeld group, which has been temporarily housed with the Field group in their new labs, will move back to their new labs by the end of the summer. The completion of the Steinfeld labs will mark the completion of the renovations in the basement of building 2, 4 and 6.

Renovations for the Schrock and Cummins groups on the 3rd and 4th floors of building 6 are nearing completion and these groups will move back to their new labs by the end of this summer. The Schrock group will be moving back from swing space on the 1st floor of building 18, clearing the way for Phase One renovations in building 18. The Cummins group will be moving back from swing space in the former Seyferth labs on the 2nd and 3rd floors of building 2, making this space available for Professor Jamison use as swing space during the renovations of building 18 and for the initial, temporary, space for Professor Sadighi who will be joining the department in July of 2001.

Renovations for the second half of the Ceyer labs are tentatively scheduled to begin in the fall of 2001. The actual date will set once a new instrument and constructed and is operational in the new space, allowing an existing instrument in the un-renovated space to shut down.

The renovation program for building 18 is progressing and is currently on schedule. Preparation of construction documents (CDs) are underway and are expected to be issued for bidding in September of 2000 with Phase One renovations commencing soon there after. In Phase 0, taking place this past spring and over this summer Temporary Faculty Offices (TFOs) have been located adjacent to building 18 and have been occupied by Headquarters, six faculty and three support staff so that space in 18 can be made available for renovations and for swing space for the researchers remaining in the building. Also occurring over the remainder of the summer and early fall will be the compression of the research labs to empty approximately one-third of the building for renovations in Phase One. Phase Two is scheduled to begin in the summer of 2001 and Phase Three in spring of 2002.

Phase IV represents the final phase of renovations to Chemistry's space. The laboratories previously assigned to Deitmar Seyferth on the 2nd and 3rd floors of building 2, unarguably the wet laboratories in the worst shape at the start of the renovations program, will be renovated to the general design and level of finish as those of Professors Schrock and Cummins' laboratories currently under renovation in Phase III. Renovations to the Seyferth space was assigned to the last phase for two reasons. First, Seyferth preferred not to endure renovations in the final years before his retirement in July of 1999. Second, in anticipation of Seyferth's retirement, we were able develop a plan to use these labs as swing space during the Phase III renovations, and later, during the building 18 renovations. In 2002–2003 when these labs are longer needed as swing space they will be renovated for Joseph Sadighi, an inorganic chemist joining the department in July of 2001.

The major lab design features of the Phase III/IV design are the separation of student desks from the laboratory and the elimination of unconditioned fumehood makeup air. The latter can be accomplished by the adoption of horizontal opening fumehoods, even while increasing the total liner feet of hood space. In Phase III the change to horizontal opening sash fumehoods has allowed the elimination of the unconditioned auxiliary hood make up air system and a downsizing of the building HVAC system by roughly 50%. This approach will result in reduced building operation costs.

In addition to the completion of the laboratory renovations, the other major objective of the Phase IV renovation is the correction of the non-compliant rooftop fumehood exhaust system for building 2. During the course of renovations to Professor Nocera's labs in Phase I it was discovered that fumes from all of the hoods in building 2 were not being properly dispersed at the rooftop. A smoke test conducted by the Industrial Hygiene Office revealed that fumes pool on the roof could create an unsafe condition for Department of Facilities maintenance personnel and contractors, and can spill over the edge of the roof. The latter creates the opportunity for chemical fumes to be pulled into the building fresh air intake duct located in the courtyard formed by building 2,4,6, and 8, and generally enter the buildings through windows. The conventional means of correcting this condition is with exhaust stacks that are at least 10 feet above the highest structure on the roof. However, on the building 2 roof this is not possible owing to the high roof parapet, roof top structures and adjoining buildings. Exhaust stacks some thirty plus feet tall would be required. Numerous stacks of this height would be very difficult to secure and would be unacceptably visible from Killian Court. The architects and engineers developed a design to correct this problem, however its implementation had to be deferred to the phase IV. Briefly, the solution incorporates the manifolding the exhaust stacks from all of the fumehoods in building 2 at the roof top and exhausting at a very high rate to ensure proper

dispersal of the fumes. Implementation of this design will require a upgrade of all of the fumehoods and fumehood controls in building 2. This activity represents a substantial portion of the estimated cost of Phase IV.

EDUCATION

In the Fall of 1999, 54 students entered the graduate program of the Chemisty Department and from September 1998 through June 1999 the department awarded 42 Ph.D. degrees. The number of graduate students in our program is expected to increase significantly as we rebuild the faculty to its previous level, and 63 students will enter the program in the fall of 2000.

Enrollment in undergraduate chemistry courses has leveled off after increasing ca. 67% over the period 1987–1995. Three courses; 5.11, 5.12 and 5.60 are each taken by approximately 40% of the MIT undergraduate student body and most of our graduate teaching assistants are assigned to these service courses. The committee on the Chemistry Curriculum continues to review the undergraduate educational program and spearhead the introduction of new courses. Recent initiatives include a "capstone experience" course 5.21 ("Design and Synthesis") which received national attention in an article in *Chemical & Engineering News* (June 7, 1999). This January, two IAP chemistry laboratory courses, 5.302 ("Introduction to Experimental Chemistry") and 5.301 ("Chemistry Laboratory Techniques"), were offered and attracted considerable interest among freshmen. In the area of graduate chemistry education, the Chemistry Faculty approved a number of changes in the system for advising and supervising graduate students which went into effect this academic year. The aims of these changes include improving communication between students and faculty, reducing stress and ensuring that every student develops substantive relationships with faculty members besides their research supervisor.

A peer mentoring program has been introduced to facilitate the training of Teaching Assistants. Graduate students who excelled as TA's in recent years were trained in providing feedback and support to novice TA's throughout the term. In addition, all current TA's now collect mid-term formative feedback from their students in an effort to promote and enhance effective teaching.

At the Senior Recognition Dinner in May, the recipients of the 2000 Undergraduate Chemistry Awards were announced:
The Alpha Chi Sigma Award (for achievement in research, scholarship and service to the department) - Connie Lu and Rachel Stanley
American Institute of Chemists Foundation Award (in recognition of outstanding achievement, ability, leadership and character) – Cynthia Liang
The Merck Index Award (for outstanding scholarship) – Eric Ferriera, Mark Stoykovich and Alice Wang
Research Award (for outstanding research in the field of chemistry) – Qinghao Chen, Daniel Crawford, Andrew Greytak and Krzystof Rybak
Hypercube Scholar (for outstanding achievement in the area of computational chemistry) – Thomas Baker
The Frederick D. Greene Teaching Award (for outstanding contributions in the area of teaching) – Victoria Gomez and Alice Wang
Service Award (for significant contributions in the area of service to the department) – Isabelle Halphen and Clifton Leigh

RESEARCH HIGHLIGHTS

Jianshu Cao used a modulated N-conformational-channel reactive system to model the recent single-molecule enzymatic experiment. This theoretical work helps establish the differences between single molecule and molecular ensemble chemistry.

Christopher Cummins showed that heterodinuclear Nb/Mo systems can effect the reductive cleavage of dinitrogen. Significant in this case is the first example of dinitrogen splitting by a heterodinuclear system.

Catherine Drennan determined the first structure of a nickel-dependent carbon monoxide dehydrogenase. This structure provides a much-awaited picture of the nickel-iron-sulfur cluster used in the biological oxidation of carbon monoxide.

John Essigmann devised the first system by which the mutagenic activity of a DNA adduct could be determined in all possible sequence contexts. Results showed that DNA repair proteins selectively repair adducts in some contexts in vivo.

Robert Field discovered that, at high excitation, the bending vibrations of acetylene become increasingly regular and localized rather than chaotic and coupled over the entire molecule. Moreover, the most stable motion is directly along the minimum energy pathway between acetylene and vinylidene, an unstable isomer of C_2H_2 (lifetime shorter than 1 picosecond) which is a postulated intermediate in many organic and inorganic reaction mechanisms.

Gregory Fu developed mild methods for effecting a variety of powerful palladium-catalyzed carbon-carbon bond-forming processes, including the Suzuki, Heck, Stille, and Negishi reactions. These processes will find application in both academia and industry. In addition efficient new catalytic asymmetric processes were devised.

Barbara Imperiali, in research targeted at the design and synthesis of new mini-protein motifs with defined structure and function, recently completed the iterative design of a new miniprotein with predominantly β-structure. This miniprotein includes 32 amino acid residues and a single disulfide bridge. The new motif demonstrates a distinct molecular architecture for future design efforts targeted at the assembly of functional constructs.

Timothy Jamison developed three novel catalytic organic reactions that assemble useful molecules in a single operation from simple and convenient starting materials. The catalytic reductive coupling of an alkyne and an aldehyde provides a high-yielding, one-step method of synthesizing allylic alcohols.

Stephen Lippard discovered from fundamental research that treatment of human breast and ovarian cancer cells with steroid hormones caused expression of HMG-1 proteins that sensitized the cells to platinum anticancer drugs. A clinical pilot study was just approved at the Dana Farber Cancer Institute and Mass General Hospital to treat ovarian cancer patients by a similar strategy. Novel fluorescent sensors for zinc and nitric oxide were reported that eventually will facilitate their detection in neurochemical signaling pathways.

Jun Liu's most important contribution this year is the discovery of a novel mechanism of regulation of gene transcription by calcium signaling.

Keith Nelson used Femtosecond to launch lattice vibrational waves that travel through their host crystals at light-like speeds, and additional femtosecond pulses were generated, arriving at later times and different locations, to manipulate the lattice waves as they move. This approach has fundamental applications in nonlinear lattice dynamics and practical applications in ultrahigh-bandwidth signal processing.

Daniel Nocera achieved, for the first time, "photosynthesis in a beaker." The overall strategy is conceptually no different than photosynthesis, distinguished only by the nature of the energy-rich products. In the leaf, sugar and oxygen are produced as fuels. In Nocera's beaker, the fuels are hydrogen and halogen gas, produced from the photocatalytic splitting of HX by a rhodium compound developed in the Nocera group.

Richard Schrock synthesized complexes that catalyze a variety of asymmetric olefin metathesis reactions. In a large number of cases these reactions proceed to give products with an enantiomeric excesses of 95% or better, in some cases essentially 100%. These are the only reported catalysts that will carry out such reactions and are expected to have a significant impact in the synthesis of drugs and pharmaceuticals. The group also discovered how to prepare a wide variety of sterically crowded cationic complexes of zirconium that will polymerize ordinary olefins such as ethylene in a living manner. They are the only olefin polymerization catalysts in over 40 years of research that produce relatively high molecular weight polyolefins in a wholly living manner.

Harald Schwalbe devised a model to predict the conformational averaging around the angles ϕ, ψ and χ_1 in a random coil peptide tested from NMR measurements of chemical shifts, coupling constants and cross-correlated relaxation rates.

Peter Seeberger developed the first Automated Oligosaccharide Synthesizer, providing the non-specialists access to pure carbohydrates for biochemical and biophysical studies. A second major achievement is the synthesis of diverse libraries of heparin-like glycosaminoglycans. These defined oligosaccharide structures are used as molecular tools to identify heparin sequences responsible for interactions with a variety of proteins involved in signal transduction events.

Lawrence Stern discovered a new pathway for antigen presentation and molecular characterization of the T cell activation mechanism. In most cells, protein degradation and MHC peptide loading occur in intracellular digestion compartments. It was recently discovered that dendritic cells carry empty MHC proteins on their surface, and can

directly load peptides from the extracellular medium. Dendritic cells are the "sentinel" cells of the immune system, with unique capabilities in activation and control of T cells. This work could lead to anti-tumor vaccines.

Jeffrey Steinfeld and collaborating investigators experimentally demonstrated Ring-Down Spectroscopy in the mid-infrared region. This technique is being developed as the basis of an ultra-high-sensitivity detection method for explosives and other contraband materials, and can also be used for measurement of trace species present in the atmosphere.

Bruce Tidor developed a novel and important theory for quantifying and analyzing the specificity of molecular interactions. The work shows that a natural tight-binding protein complex uses optimized electrostatic interactions as a prime mechanism for achieving stability. A new and general mechanism for enhancing the stability of proteins has been discovered through theoretical work and verified experimentally.

More information about the Department of Chemistry can be found on the World Wide Web at http://web.mit.edu/chemistry/www/.

Stephen J. Lippard

DEPARTMENT OF EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

The Department of Earth, Atmospheric and Planetary Sciences (EAPS) has broad intellectual horizons that encompass the solid earth, its fluid envelopes, and its diverse neighbors throughout the solar system and beyond. We seek to understand the fundamental processes defining the origin, evolution and current state of these systems and to use this understanding to predict future states. The Department comprises 35 faculty, including two with primary appointments in Civil and Environmental Engineering, 185 graduate and undergraduate students, and 103 research staff, postdoctoral appointments and visiting scholars. EAPS is notable for its collaborations with other MIT Departments and Schools to address complex interdisciplinary problems.

EDUCATIONAL ACTIVITIES

EAPS has vigorous graduate educational programs in geology and geochemistry, geophysics, atmospheres, oceans, climate, and planetary science. Each disciplinary area of EAPS continues to be ranked among the top graduate programs in the country, with most areas being rated either first or second nationally. The EAPS graduate program currently focuses on the Ph.D. degree, which is the goal of about 90% of its graduate students. During the past academic year, 151 graduate students were registered in the Department including EAPS students in the MIT/Woods Hole Oceanographic Institution (WHOI) Joint Program. Of these 107 are U.S. citizens and 44 are international students. Women constitute 44% of the graduate student population. Sixteen Ph.D. and fifteen S.M. degrees were awarded during the past academic year (1999–2000).

The new EAPS Master's Degree Program in Geosystems graduated its third class this year. The program's novel curriculum is designed to educate geoscientists in system-level analysis and prepare them for professional careers in high-technology industries concerned with complex geosystems. The degree requirements comprise 108 units of course work, including the novel two-semester, 30-unit Geosystem basetrack subject, and a masters thesis. All five of the entering students successfully completed the course work in two semesters; with all five graduating in June. Another relatively new degree program is administered by the department's Program in Atmospheres, Oceans and Climate (PAOC). This new Ph.D. in Climate Physics and Chemistry has 12 students currently enrolled. Enrollment in the PAOC graduate degree programs continues to slowly increase. Two recent faculty departures now present a challenge for us to sustain the breadth of the overall PAOC program, which also includes degrees in atmospheric science and joint degrees with WHOI in oceanography, and is arguably unique in the world.

A bi-annual prize has been developed to recognize and reward the efforts of outstanding EAPS Graduate Teaching Assistants. Winners during the past year include Jason Goodman, Greg Lawson, Galen McKinley, and Noah Sayder.

EAPS continues to maintain a strong presence within the undergraduate program at MIT. The Department continues to offer a wide variety of Freshman Advising Seminars each Fall with 10 faculty members participating each of the past three years, advising almost 10% of MIT's freshman class. A new undergraduate seminar has been developed to introduce newly declared sophomore majors to the broad research interests of the faculty. This seminar was very well received during its inception and is now being modified and expanded to include one-on-one mentoring by faculty members in the areas of technical writing and oral communication. Next year EAPS will have 14 new majors which is a very significant increase above the current year (5 new majors). Professor Kip Hodges was the recipient of a substantial d'Arbeloff Grant to support development of a new multi-disciplinary project-based learning experience for freshman entitled, "Mission 2004 and Beyond."

The EAPS Independent Activities Program (IAP) continues to be one of the most vibrant at MIT, and faculty have maintained a healthy Undergraduate Research Opportunities Program (UROP). Opportunities for IAP field experience included trips to Lowell Observatory in Flagstaff, Arizona, the NASA Goddard Space Flight Center in Maryland, and a geoscience field camp in Nevada.

The Bachelor of Science curriculum was reorganized several years ago to include three areas of concentration: geoscience, physics of atmospheres and oceans, and planetary science and astronomy. Each concentration encompasses a set of required courses, a sequence of field and laboratory subjects, and independent study or thesis preparation. Historically, students have primarily chosen to specialize in either geoscience or planetary science and astronomy. In the past two years however, there have been an increasing number of students (5 to 6) pursuing studies in the physics of atmospheres and oceans. Within this concentration area, a new Institute Laboratory course has been developed that permits undergraduates to develop and perform experiments related to the general

circulation of the atmosphere and the day-to-day sequencing of weather events. EAPS undergraduate enrollment comprised 30 majors and 17 minors during 1999–2000.

FACULTY

Professor Richard Binzel was elected as a Fellow of the American Association for the Advancement of Science (AAAS).

Professor Edward Boyle was awarded the Patterson Medal of the Geochemical Society for his research in environmental geochemistry and was also elected a Fellow of the AAAS.

Professor John Edmond was awarded the Urey Medal of the European Association for Geochemistry.

Professor Frederick Frey was elected a Fellow of the Geochemical Society and a Fellow of the European Association for Geochemistry.

Professor Paola Malanotte-Rizzoli was elected President of the International Association for the Physical Sciences of the Ocean (IAPSO) which comprises more than 100 nations and more than 5,000 international members.

Professor Mario Molina received the UNEP's Sasakawa Prize.

Professor Ronald Prinn was elected and served his term as Chair for Atmospheric and Hydrospheric Sciences of the American Association for the Advancement of Science.

Assistant Professor Kelin Whipple was promoted to Associate Professor.

Professor Carl Wunsch received the Henry Stommel Research Prize from the American Meteorological Society.

The department currently has active faculty searches in six exciting areas. The first is in Planetary Science which is making dramatic advances toward understanding the formation and evolution of our solar system and other planetary systems. Observations made using recent advances in both spacecraft and earth-based sensors are enabling the development of more physically realistic models of dynamical interactions between planetary bodies, as well as the internal constitution and thermal history of individual planets and their moons.

The second faculty search is in Crustal Geophysics. Of growing importance is the need for advances in our understanding of the structures and processes of the upper crust. Areas of interest include seismic imaging, electromagnetic wave propagation, flow through porous media, sediment transport dynamics, reservoir structure, relationships among subsurface structures, and kinematics and dynamics of crustal deformation. All these areas are relevant to present and planned new activities in the Earth Resources Laboratory.

The third faculty search is in Geobiology. We envision this emerging new field to encompass research that includes the origin of life, evolutionary and developmental biology, microbial biology, and the interactions between ecosystems and climate. There are numerous opportunities for interactions and collaborations between geobiologists and faculty in our programs in climate, planetary geology, and earth geology as well as faculty in the Civil and Environmental Engineering and Biology Departments. The time is right for the expansion of the department into this exciting new field.

The fourth faculty search is in Atmospheric, Oceanic and Climate Sciences. We aim to enhance our existing programs in meteorology, oceanography and climate research including ongoing work in the Center for Global Change Science's Climate Modeling Initiative. The applicant may have any focus: theoretical, experimental, or observational; applicants capable of initiating and/or taking full advantage of the interdisciplinary nature of the department are especially being sought.

The fifth faculty search is in Experimental Geophysics and Geochemistry. We are seeking an outstanding scientist in the area of experimental geophysics and geochemistry who studies the physics and chemistry of Earth materials. Areas of interest include, but are not limited to: mechanical properties, including the study of multiphase materials or materials undergoing chemical reactions; thermal transport, fluid transport, acoustic and/or electrical properties, including flow of granular material, fluid flow through porous materials, transport of magma and flow in the mantle; and high-pressure mineralogy, mineral physics and phase transitions in planetary interiors.

The sixth faculty search is in Paleoclimate Science. We seek creative applicants with broad research interests who have a strong understanding of fundamental biological, geological, chemical, and physical processes affecting the

evolution of the earth's climate. The position is open to outstanding candidates in all areas of paleoclimatology. Observational and experimental approaches are favored; applicants capable of initiating and/or taking full advantage of the interdisciplinary nature of the department are encouraged to apply.

The department continues to pioneer work in new interdisciplinary areas. The Earth Resources Laboratory is broadening its base to include a wider range of geophysical, geological, and environmental topics. The Center for Global Change Science (including the Climate Modeling Initiative) and the Program in Atmospheric, Oceans and Climate continue to foster cross-fertilization among all areas of the earth sciences that control the climate system. Research activities are gradually broadening so that geologists are now working with oceanographers and atmospheric scientists, and models of the climate system have been constructed both for the modern system and for times deep in the geological past. A new faculty group interested in co-evolution of the geosphere and biosphere has formed and is focussing initially on understanding the great extinctions in earth's past. New geobiology faculty will further enhance interactions between the geological and climate sciences in the Department. Department faculty also continue to play leading roles in the MIT Joint Program on the Science and Policy of Global Change.

CURRENT RESEARCH

Professor Richard Binzel and Dr. Schelte Bus were responsible for approval by the International Astronomical Union (IAU) in honoring the Institute with the naming of asteroid (4523) MIT, a 15 km object orbiting in the main-belt between Mars and Jupiter. Also honored by the IAU was Neil Pappalardo. The naming of asteroid (4241) Pappalardo recognizes his support of MIT's participation in the Magellan telescope project. The Pappalardo asteroid is 5 km across and also orbits in the main asteroid belt.

Professor Samuel Bowring's group continues their work on calibrating the tempo of mass extinction and evolutionary radiations concentrating on the Cambrian explosion and the end-Permian extinction. In addition, Bowring's graduate student Mark Schmitz is using lower crustal xenoliths from the abundant diamond pipes in southern Africa to constrain the thermal history of the lower crust and in particular the time-scale of the decay of orogenic geotherms.

Professor Edward Boyle is following the decadal-scale evolution of lead in the ocean which has been introduced by human activities. His group is also working on the chemical characterization and variability of iron (an essential limiting nutrient in marine environment). He is also working on the relationship between deep ocean circulation and past abrupt changes in global climate.

Professor John Edmond's main effort has been on the chemistry of the big rivers (Mekong, Salween, Yangtze and Yellow) that arise on the Eastern Tibetan Plateau and in Western Sichuan. This is a continuation of previous work on the Tropical rivers of South America and the Arctic and Sub-Arctic rivers of Eastern Siberia. Two major expeditions have been completed with great success, one in the Summer of 1999 and another, just finished, this summer. Monitoring stations to determine the dissolved load transport into the Three Gorges Dam have also been established.

Professor James Elliot, graduate student Susan Kern, and colleagues at Lowell Observatory and the Ohio State University are conducting a survey with the Mosaic cameras at the national observatories for solar system bodies orbiting the sun beyond Neptune. So far they have found nearly 60 of these bodies, which they plan to study with the first Magellan telescope when it comes on line in 2001.

Professor Kerry Emanuel developed a new model for predicting the intensity of hurricanes. Although the model is extremely simple and was developed for pedagogical purposes, it has proven to be so much better than existing models that it is being used for actual hurricane intensity prediction by the National Hurricane Center.

Professor Brian Evans, Dr. Joerg Renner and Dr. Greg Hirth are measuring the strength of partially molten peridotites. The experiments are unique in that the pressure of the magma is maintained separately, and thus, the experiments simulate the genesis and migration of melt in volcanic source regions. Uli Mok, Yves Bernable, Wenlu Zhu and Evans have completed experiments that explore the changes of permeability during diagnoses of sedimentary rocks. Surprisingly, the permeability of the rocks changes very quickly even through the total porosity remains relatively constant. The microstructure produced in the experiments are very similar to those found in petroleum source rocks in natural formations.

Professor Frederick Frey's current research involves, dating of rocks cored from the Indian Ocean seafloor during Ocean Drilling Program Leg 183. Frey and M. Coffin (as co-chief scientists) show that ancient continental rocks

with ages ranging from 530 to 2550 million years form part of the Kerguelen Plateau: a very large volcanic province which formed a subaerial landmass as a result of extensive volcanism 110 million years ago. The finding of ancient continental rock in this younger oceanic province was unexpected.

Professor Grotzinger has started a new field project in the Sultanate of Oman, where strata deposited at the Precambrian-Cambrian boundary are extremely well preserved. These rocks contain the best proxy records of environmental change that led directly to the Cambrian radiation of metazoan organisms.

Professor Tim Grove and colleagues have been investigating processes that lead to the unique trace element abundance signatures observed in subduction zone magmas. They find that a water-rich fluid released by the dehydration of minerals carried in the subducting slab contributes most of the trace element signature to subduction zone magmas. This trace element rich fluid, "flux-melts" the overlying mantle as it ascends into the hot, shallower portion of the mantle wedge.

Professor Bradford Hager and his students developed a novel algorithm that made it possible to include realistic simulations of small-scale thermo-mechanical processes at subduction zones in large-scale numerical models of mantle convection. This advance made it possible to carry out more realistic computations of Earth's thermal history and energy budget.

Professor Thomas Herring, his students, and colleagues have been using Global Positioning System measurements to study deformations occurring before, during, and after earthquakes in California, Turkey and Central Asia. He has also been collaborating with colleagues in India and Canada on studies of the Earth's deep interior using very long baseline interferometry measurements of changes in the rotation of the Earth. He has also run a workshop for Cambridge middle school teachers on the use of data in Earth Sciences and made presentations to Lexington high school students.

Professor Richard S. Lindzen is actively investigating a possible new climate feedback which he refers to as the "Iris Effect." Using satellite cloud data, backed up by simple theory, he and colleagues have found that upper level cloud cover in the tropics decreases strongly with increasing surface temperature in such a manner as to stabilize surface temperature. The effect is being incorporated into several large-scale climate models in order to determine the impact of the Iris Effect on climate sensitivity and air-sea coupling.

Professor Paola Malanotte-Rizzoli and her collaborators have focussed on three major research issues:

- model-data synthesis in the Atlantic Ocean aimed to understand tropical/subtropical interactions through the assimilation of TOPEX altimetry and WOCE dataset. This research is in collaboration with Dr. Busalacchi and his group at Goddard Space Flight Center.
- predictability of geophysical fluid flows under the Departmental Research Initiative (DRI) of the Office of Naval Research. Dr. Malanotte-Rizzoli is one of the three scientific Directors of the DRI
- physical and biochemical modeling of marginal seas, with a focus on the Mediterranean and Black Seas as contrasting ecosystems.

Zhang Peizhen of China's State Seismology Bureau, Will Downs of Northern Arizona University, and Senior Research Scientist Peter Molnar have shown that sedimentation rates around the world increased at 2.5-3 million years ago when global climates abruptly became colder and drier. This poses the question: how did climate change effect increased erosion rates? They suggest that the switch from a stable climate to one that oscillates rapidly and with large changes maintains the erosive system in disequilibrium and therefore prevents it from approaching a steady state of slow erosion.

Recent achievement in Professor Mario Molina's group include experiments and theory leading to an improved understanding of phase transitions in tropospheric aerosols and their role in climate change; investigations of important reactions between gaseous free radicals and organic atmospheric aerosols; and studies of the connections between economic, social and scientific aspects of the air pollution problem in megactities of the developing world.

Professor Reginald Newell flew aboard a NASA research aircraft measuring atmospheric trace constituents in a tropical Pacific mission in the spring of 1999. He and his colleagues discovered a duct of sinking motion along the equator about 800 km wide and several thousand km long, bordered by two regions of rising motion and cloud which extended to about 11 km altitude. The climatology of the duct, its possible role in acting as a double barrier to the north-south transport of trace constituents, and the physical mechanisms responsible for it, are presently under study.

Studies of atmospheric chemistry using multi-dimensional models in Professor Ronald G. Prinn's group (especially Drs. Chien Wang and Monika Mayer) have identified and quantified the very significant effects of the non-linear chemistry in polluted urban areas on the chemistry and climate at regional and global scales. Wang and Prinn have also demonstrated the significant role of deep convection and its associated lightning on the chemistry of ozone in remote areas.

In their recent studies of natural landscapes, Professor Daniel Rothman and his group have carefully evaluated the theoretical and empirical evidence in favor of scaling and universality in river networks. In a new area of interest, Rothman has studied concurrent paleontological and geochemical records for the past 500 million years, and has found quantitative evidence that global carbon dioxide levels, and the carbon cycle itself, are significantly coupled to global biodiversity.

Professor Peter Stone and his former student Dr. Amy Solomon have used an efficient three-dimensional numerical model to study the interaction of atmospheric eddies (cyclones and anti-cyclones) with the mean state of the atmosphere. They find, as has been frequently speculated, that the eddies are very efficient at homogenizing the potential vorticity structure of the mid-latitude atmosphere, but only in the lower troposphere. The result is robust over a wide range of forcing parameters.

Prof. M. N. Toksöz, along with his colleagues and students, have been deeply involved with the tectonic and seismological studies of two devastating earthquakes that occurred in Turkey in August and November 1999. These two earthquakes have increased the probability of a major earthquake further west on the North Anatolian Fault, that could affect a population of 13 million people near Istanbul. The MIT team has increased their geophysical monitoring to better evaluate the earthquake hazard in the region.

Using a variety of seismic imaging techniques, Professor Robert D. van der Hilst and his research group are studying the lateral variation in seismic properties (including anisotropy), the variations in depth to major interfaces, and the presence of scatterers deep in Earth's interior. Recently, they made significant progress toward mapping mantle anisotropy and crustal thickness beneath Australia, which will help to understand the long-term deformation and evolution of continents, and lead toward improving tomographic images of Earth's lowermost mantle.

Professor Kelin Whipple's current research agenda represents an integrated effort to discover: the quantitative relationships between climate, tectonic setting, rock type, and the elevation and relief of mountain belts; the controls on the timescales of mountain building and decay; and the nature of the sediment supply signal delivered to depocenters (both on-shore and off-shore) during an orogenic cycle. Exciting new developments in recent months include minimum estimates of landscape response time that argue against the often-invoked steady-state assumption, analysis of the role of sediment flux in modulating river incision rates, and refinement of a river incision law to allow prediction of patterns and rates of tectonic uplift in suitable field localities.

Professor Jack Wisdom has continued his investigations of the non-linear dynamics of coupled core-mantle systems subject to astronomical forcing. Earth and Venus can evolve chaotically as tidal friction carries them through resonances between the core precession period and the orbital period. Consequences for the thermal history of Earth and Venus are being investigated. He has also finished his book on classical mechanics with Professor Gerald Sussman in EECS. The book presents mechanics from a modern non-linear dynamics perspective, and makes extensive use of simulation for active exploration of non-linear phenomena in mechanics.

Professor Carl Wunsch and his group are working with collaborators at several other institutions on estimating the complete global ocean circulation as it changes from day-to-day. It is now possible to produce three-dimensional oceanic fields and properties (such as heat flux) as they vary under atmospheric forcing and internal instabilities using a general circulation model and the new global oceanic data sets.

Professor Maria Zuber and colleagues used gravity and altimetry data from their experiments on the Mars Global Surveyor spacecraft to produce the first high integrity global models of the structures of the crust and lithosphere of Mars. The models yielded a new view of the early thermal evolution of Mars, including the history of water and climate. Professor Zuber's laser ranging instrument on the NEAR Shoemaker spacecraft has yielded the highest quality shape model ever produced for a solar system small body, near Earth asteroid 443 Eros.

More information about this department can be found on the World Wide Web at http://www-eaps.mit.edu/.

Ronald G. Prinn

DEPARTMENT OF MATHEMATICS

The Department of Mathematics at MIT seeks to improve upon its top ranking in both research and teaching by aggressively hiring the very best faculty, with special attention to the recruitment of top women and under-represented minority candidates, and by continuing to serve the broad and varied educational needs of its graduate students, the mathematics majors, and all undergraduates of the Institute.

STUDENTS

During the academic year 1999–2000, there were 278 undergraduates majoring in mathematics, 239 in Course XVIII, Mathematics, and 39 in Course XVIII-C, Mathematics/Computer Science. Bachelor of Science degrees, including double majors, were awarded to 94 students, 85 in Course XVIII and 9 in Course XVIII–C. There were a total of 100 graduate students in mathematics, all in the Ph.D. program. This year 17 students received the doctoral degree, and 3 the Master's degree.

FACULTY CHANGES

Professor James Munkres retired from MIT after 40 years of distinguished service on the Mathematics Faculty.

Assistant Professor of Applied Mathematics Martin Bazant (computational fluid dynamics) was promoted from an Applied Mathematics Instructorship appointment in January. Assistant Professor Byunghan Kim (mathematical logic) was also promoted from the CLE. Moore Instructorship in January. Dr. Igor Pak will join the department as Assistant Professor of Applied Mathematics. Specialized in algebraic combinatorics, he is currently a J. W. Gibbs Instructor of Mathematics at Yale University.

Associate Professor Sergey Fomin resigned from MIT for a faculty position at the University of Michigan.

Administration

Professor Michael Artin will follow Professor Richard Stanley as Chairman of the Undergraduate Committee. Professor Daniel Kleitman will chair the Applied Mathematics Committee following Professor Michael Sipser, who will succeed Professor James Munkres as Chairman of the Committee of Advisors. Professor Richard Melrose will continue as Chairman of the Pure Mathematics Committee, and Professor Tomasz Mrowka as Chairman of the Graduate Student Committee.

RESEARCH

Here are a few snippets from the great range of research underway in the department.

Sigurdur Helgason is working on problems concerning the Radon transform corresponding to the double fibration relative to two symmetric subgroups of a semisimple Lie group. Steven Kleiman, in collaboration with Eduardo Esteves and Mathieu Gagne, proved an autoduality theorem for the relative compactified Jacobian and a family of curves with arbitrary double points. With W. Wakimoto, Victor Kac developed representation theory of affine superalgebras and discovered its connection to the theory of elliptic functions. Gerald Sacks is currently working on the invariant Post problem and the minimal upper bound problem for hyperdegrees in recursion theory; and, with Jessica Young, on the Vaught conjecture in model theory.

Byunghan Kim is investigating the relationship between stable structures and simple structures in model theory. Santosh Vempala formulated an algorithmic theory explaining how the brain can effectively learn concepts from a small number of examples. He also developed a rigorous analysis for the heuristic known as spectral clustering, and proved that the traveling salesman problem cannot be approximated to within 2% of the optimum. (This proof is novel in that it uses a probabilistic analysis to obtain the deterministic lower bound.)

Six MIT undergraduates participated with five mathematics graduate-student mentors in the department's third Summer Program in Undergraduate Research (SPUR), which offers a six-week program of full-time research experience culminating in written papers and lectures to faculty.

Summer 1999 was the seventh year of the Mathematics department's participation in the Research Science Institute program for gifted high school students, in which seven mathematics graduate students mentored twelve high school students from the US and abroad for a five-week period.

HONORS, PRIZES AND AWARDS

Professor Aise Johan de Jong received the Frank Nelson Cole Prize in Algebra of the American Mathematical Society (shared with Andrei Suslin) "for important work on the resolution of singularities by generically finite maps."

Professor Isadore Singer received the Leroy P. Steele Prize for Lifetime Achievement of the American Mathematical Society for his series of five papers with Michael P. Atiyah on the Index Theorem for elliptic operators (which appeared in 1968–71) and for his three papers with Atiyah and V. K. Patodi on the Index Theorem for manifolds (which appeared in 1975–76) which are among the great classics of global analysis.

Professor Richard Stanley was selected to be the initial Norman Levinson Professor of Applied Mathematics through June 2005.

Associate Professor Bonnie Berger received the TR100 Award of *Technology Review* for 100 top young innovators for the 21st century.

Associate Professor Michel Goemans received an IBM Faculty Partnership Award.

Concerning the graduate students: Ioana Dumitriu received the Provost's Women/Minority Graduate Fellowship for 2000–2001. The Housman Graduate Student Teaching Award was given to Alexander Perlin and Catalin Zara for their exceptional skill and dedication to teaching. Bojko Bakalov and Kiran Kedlaya were each awarded the Charles W. and Jennifer C. Johnson Prize for an outstanding research paper accepted in a major journal by a graduate student in mathematics. The Clay Mathematics Institute selected Bojko Bakalov, Kiran Kedlaya, and Catalin Zara for its initial *Liftoff* postdoctoral research program for summer 2000.

Senior Benjamin Wieland was awarded the Jon A. Bucsela Prize in Mathematics in recognition of distinguished scholastic achievement. Among those seniors awarded degrees in mathematics, six were elected to Phi Beta Kappa.

The MIT Mathematics team, comprised of Sophomores Kai Huang, Abhinav Kumar, and Hoe Teck Wee, finished sixth in the 1999 William Lowell Putnam Intercollegiate Mathematical Competition. Abhinav Kumar was among the six highest ranking individuals and was therefore designated a Putnam Fellow. MIT had three other individual scores in the top fourteen, and another six individuals were given Honorable Mention for finishing in the top 60. A total of 2900 students from 431 colleges and universities in Canada and the US participated in the competition. MIT had the largest number of individuals (10) in the top 60.

EDUCATIONAL

The Undergraduate Mathematics Committee, led by Richard Stanley (the Undergraduate Chair) added two new courses to the calculus options required of all MIT students. They are 18.013A and 18.023A Calculus with Applications, which are accelerated versions of the applied options 18.013 and 18.023. These new courses supply an applied analogue of the accelerated versions 18.01A and 18.02A Calculus of the standard calculus courses 18.01 and 18.02. There were significant changes this year regarding mathematics majors. For academic year 2000–01 the number of freshmen who chose mathematics as their major is 72, up from 49 for 1999–00, and the highest number since 1973. There is a trend for more students, especially from course 6 to earn a second degree in mathematics. Over the last three years, the percentage among junior and senior mathematics majors in this category increased from approximately 25% to 50%.

More information about the Mathematics Department can be found on the World Wide Web at http://www-math.mit.edu/.

David A. Vogan, Jr.

DEPARTMENT OF PHYSICS

Physics faculty members continue to receive recognition by the outside community. Robert Birgeneau received the Julius Edgar Lilienfield Prize from the American Physical Society. Mildred Dresselhaus was awarded the Nicholson Medal for Humanitarian Service from the American Physics Society and the Weizmann Women in Science Millennium Lifetime Achievement Award. Jerome Friedman received the Presidential Medal from the Institute of Physics. Marc Kastner was awarded The Oliver E. Buckley Prize in Condensed Matter Physics from the American Physical Society. Wolfgang Ketterle received The Benjamin Franklin Award in Physics from the Franklin Institute and the Dannie-Heineman Prize from the Academy of Sciences, Gottingen, Germany. John King was awarded the Oersted Medal by the American Association of Physics Teachers. Philip Morrison and his wife Phylis received the National Science Board Public Service Award from the National Science Board. We are proud that several of these awards are for contributions to science education.

Xiao-Gang Wen, Jacqueline Hewitt, and Barton Zweibach were promoted to full Professor. Takashi Imai was promoted to Associate Professor without tenure. New faculty in the department are Gunther Roland, Alexander van Oudenaarden, and Frank Wuerthwein, who have all been appointed Assistant Professor. We are delighted that one of the leading particle theorists in the world, Frank Wilczek, has joined our faculty to become the first Herman Feshbach Professor of Physics.

EDUCATION

This year the department begins an ambitious program to see if freshman physics education can be made more exciting. We propose to establish a "technology enabled active learning" (TEAL) environment for large enrollment physics courses at MIT, which will serve as a national model for such instruction. We will merge lecture, recitations, and hands-on laboratory experience into a technologically and collaboratively rich experience for incoming freshmen. A dozen or so students will gather, with ten or so such groups in a common area, for five hours per week. They will be exposed to a mixture of formal instruction, lab work with desktop experiments, and collaborative work in smaller groups of three or four, in a computer rich environment (one networked laptop per three students).

The degree of S.B. in Physics provides MIT students an unsurpassed preparation for graduate study in physics. However, many students, although strongly attracted to physics, have broader interests that will take them into different careers after graduation. We have, therefore, initiated a new degree that will provide students with an understanding of the fundamentals of physics and an appreciation of the physicist's approach to problem solving, while requiring a focus in some area that will support career options other than a Ph.D. in physics.

The department has taken several steps in the past year to improve the graduate experience for our students. Although the mean time to a Ph.D. degree in the department (5.7 years) is consistent with the national average (6.1 years), we are concerned that some of our students were taking significantly longer than this. To address this we have established new rules governing the number of terms a student can be in the department before submitting a thesis proposal and having a thesis committee appointed.

DIVERSITY

The MIT Department of Physics is in the forefront in producing minority Ph.D.'s. To recruit new minority graduate students, we have continued to support our students' membership in the National Conference of Black Physics Students (NCBPS) and the National Society of Black Physicists (NSBP). Despite these efforts, the pool of qualified minority candidates for graduate school remains extremely small and qualified students are aggressively recruited by all our competitors. The same is true of women. While the fraction of women students is higher than for most institutions it is still painfully small. Our women students have established an organization "Women in Physics at MIT" (see http://web.mit.edu/physics/wphys/), which has become very active in the last year. This organization has received financial support from an alumna of our department.

The department has acted aggressively to attract women and minority faculty members. For the academic year 2000–2001, we have made two offers to women, one of whom has already accepted.

PAPPALARDO FELLOWS IN PHYSICS

Neil Pappalardo has made possible a new program in the department to support individuals of exceptional promise, who have recently received, or who are about to receive, a doctoral degree in Physics, Astronomy, or related fields. One of the features that distinguishes the sciences in general, and physics in particular, is the importance of the accomplishments of outstanding individuals. The purpose of the Pappalardo Fellowships in Physics is to identify

and support unusually talented young physicists, and to provide them with the opportunity to pursue research of their own choosing.

The Pappalardo Executive Board selects three fellows each year on the basis of their demonstrated talent, accomplishments, originality, and capacity for independent work. The fellows are appointed for three-year terms with a stipend higher than typically postdoctoral fellows and a small amount of discretionary funds for travel or other research expenses. The Pappalardo Fellows have complete freedom in their choice of research and are matched with a mentor chosen on the basis of their research interests. Fellows meet for lunch once per week and for dinner once per month, along with the Executive Board, mentors, and their guests. The first three Fellows will begin their appointments in September of 2000.

RESEARCH HIGHLIGHTS

Most physics research is done through participation of our faculty in labs and centers. The research of the Physics Department faculty is specifically addressed in the following lab and center reports: Laboratory for Nuclear Science, including the Bates Linear Accelerator Center and the Center for Theoretical Physics; the Center for Materials Science and Engineering; the Research Laboratory of Electronics; the Center for Space Research; the Plasma Fusion Center; the Harrison Spectroscopy Laboratory; and the Haystack Observatory. Rather than an overview, we discuss here a few highlights to give a sense of the excitement of research in the department.

Lisa Randall is one of the world's experts on extensions of the Standard Model of particle physics and on exotic experimental signatures for new physics at high energies that would tell us what extensions are correct; her field is called particle phenomenology. This year she received great attention for incorporating the idea of extra dimensions, developed by string theorists, into particle phenomenology.

The Standard Model describes all the known fundamental particles and their interactions. We know that hadrons are composed of quarks that interchange gluons; quantum chromodynamics (QCD) is the theory that describes how quarks and gluons interact. At short distances, inter-quark forces are weak, and QCD describes them with great precision. As quarks move apart, however, the forces between them become extremely strong, making it impossible for quarks to exist in isolation. However, during the big bang, the temperature was so high and the density of quarks was so high, that new states of quark matter may have existed. Krishna Rajagopal has predicted some of the properties of these states of matter, some of which may be created in collisions of heavy ions. The major MIT experimental effort in heavy-ion physics is the PHOBOS detector under the leadership of Wit Busza, Leslie Rosenberg, and Boleslaw Wyslouch. PHOBOS has observed the first collisions at the Relativistic Heavy Ion Collider (RHIC) this spring. The coming year will be the one in which new physics emerges.

The Magellan telescopes, to be dedicated in December of this year, will allow MIT astronomers to compete with Caltech and University of California in studying objects at what is, effectively, the edge of the universe. Objects to be studied include gamma ray bursts, supernovae, high redshift galaxies, and gravitational lenses.

LIGO is a $300 Million NSF project to measure gravitational radiation heretofore undetected, most probably from compact objects. The dedication of the two observatories, one in Louisiana and one in Washington State took place in February. MIT and Caltech are the two lead institutions. Weiss has played a very important leadership role in the development of instrumentation for LIGO.

The department has a strong presence in X-ray and gamma-ray astronomy. The group includes Hale Bradt, Claude Canizares, Deepto Chakrabarty, Walter Lewin, and Saul Rappaport. Bradt is nearing retirement and Chakrabarty is the only junior faculty member. The Chandra X-ray Observatory (CXO) is one of NASA's four "great" observatories, CXO gives the same improvement in resolution at X-ray wavelengths that the Hubble Space telescope gives at optical wavelengths. Two of the instruments on CXO were developed at MIT, and the science center is split between MIT and Harvard/Smithsonian. Wonderful discoveries have already been made by CXO and many more are anticipated.

Thousands of gamma-ray bursts have been detected, but less than a dozen have been identified with specific objects, so that observations can be carried out at other wavelengths. HETE (High Energy Transient Explorer) is an MIT project has been localizing approximately one burst per week since January 2000.

Birgeneau and Kastner are involved in a collaboration that discovered waves of magnetic ordering in high temperature superconductors. This is very surprising since it is widely believed that magnetic ordering and superconductivity should compete with each other. Tadashi Imai has used nuclear resonance to find waves of charge ordering as well.

TRANSITION

Professor Toyoichi Tanaka, a world leader widely recognized for his revolutionary discovery of phase transitions in polymer gels, died of heart failure on Saturday, May 20, while playing tennis. He was 54. Toyo will be deeply missed by his family, his friends, and colleagues at MIT and around the world. His death is a great loss to the scientific community as a whole.

Robert J. Birgeneau, Cecil and Ida Green Professor of Physics, became President of the University of Toronto on July 1, 2000. We are proud of Birgeneau's new status as President of one of the greatest universities in the world, but will miss him in the department.

More information about this department can be found on the World Wide Web at http://web.mit.edu/physics/.

Marc Kastner

CENTER FOR LEARNING AND MEMORY

The mission of the Center for Learning and Memory is to decipher molecular, cellular, neuronal ensemble, and brain systems mechanisms underlying learning and memory and associated cognitive functions such as perception, attention and consciousness.

In order to fully understand complex cognitive phenomena such as learning and memory, it is necessary to analyze them at multiple levels of complexity: at the molecular level, at the synaptic level, at the cellular level, at the neuronal ensemble level, and at the level of behavior of a whole living animal.

At the center we accomplish these challenging objectives by applying, in combination, an assortment of cutting edge experimental technologies that include behavioral mutants of fly, molecular and cell biology, genomics, electrophysiology of cultured neurons and brain slices, two photon laser microscopy, combined behavioral and single-unit recording and analysis of monkeys, large scale recording of the activity of neuronal ensembles of freely behaving rodents, and a wide array of behavioral paradigms

Two new faculty members were recruited last year. J. Troy Littleton joined the center in as an Assistant Professor in the Department of Biology. He arrived at MIT in January, and has already acquired an NIH R01 grant and attracted four biology graduate students and two postdoctoral fellows to his lab. Yasunori Hayashi joined the Center in July from Cold Spring Harbor Laboratories. He is an investigator in RIKEN-MIT Neuroscience Research Center and an Assistant Professor in the Department of Brain and Cognitive Sciences.

FACULTY RESEARCH DEVELOPMENTS

Yasunori Hayashi's laboratory focuses on a region in the brain called the hippocampus which is burried deep in the cerebrum. To study the phenomenon called long-term potentiation or LTP, the lab combines different technologies. They construct various recombinant neuronal proteins and express them in neurons using molecular biological techniques. Then, they analyze the expressing cells using electrophysiological and two-photon microscope techniques. They also study another peculiar phenomenon in the hippocampus: neuronal regeneration. We use a genetically altered animal to specifically ablate this process and study the effect of loss of neuronal regeneration on learning and memory. Through these analyses we would like to know the molecular events that mediates memory in mammalian brain.

The focus of research in Troy Littleton's laboratory is the elucidation of the molecular mechanisms underlying synapse formation, function and plasticity. They combine molecular biology, protein biochemistry, electrophysiology, electron microscopy and imaging approaches with *Drosophila* genetics to investigate molecular mechanisms involved in neuronal signaling. Current genetic approaches in the lab include the identification and characterization of novel temperature-sensitive paralytic mutants in *Drosophila* as a tool to identify and study new components of neuronal signaling pathways. Many of these temperature-sensitive paralytic mutants alter synaptic sprouting, membrane excitability or synaptic transmission, thus allowing the researchers to pursue novel gene products involved in epilepsy, synaptic plasticity and synapse stability.

Guosong Liu's lab studies the mechanisms that control the levels of NMDA receptor activation at single synapses. This is a critical issue for the understanding of molecular mechanisms of synaptic plasticity. They found that the levels of NMDA receptor activation during synaptic transmission are determined by the concentration of transmitters in the synaptic cleft and can be enhanced by genetic modification of the NMDA gene. These findings shed new light on the mechanisms controlling NMDA receptor activation during synaptic transmission.

Earl Miller's lab found a neural correlate of the concepts "match" and "nonmatch" in monkeys that could apply them to any image. They also found prefrontal neurons that conveyed which of 3 complex rules a monkey was currently using. Finally, they discovered a neural correlate of perceptual learning. After 5 days practice with a set of objects, monkeys were better at recognizing them when they were degraded with noise. Practice also resulted in fewer neurons being activated in their prefrontal cortices, but these neurons communicated more information and were better at discriminating the degraded objects compared to when they were novel.

At the cellular level little is known about mechanisms underlying activity-evoked synaptic remodeling during visual system development. In Elly Nedivi's lab, screening a pool of candidate plasticity genes (cpgs) that they previously identified revealed a subset that are expressed in the developing visual cortex and are activated by light, suggesting

they may be involved in activity-dependent aspects of visual system development as well as everyday efficient function. They are now using cpgs as molecular tools to probe activity-dependent plasticity in the visual system.

William Quinn's laboratory isolates new *Drosophila* mutants that affect learning and clone the altered genes to discover genuinely novel information about learning and memory. One of the mutants they have isolated flunks one long-term memory test established by vertebrate researchers, but passes the second like normal flies. These studies indicate that there are at least two separate types of long-term memory. Understanding one form of long-term memory—consolidated memory—depends on cloning the mutant's gene. The lab has localized the gene to a 180-kilobase interval of DNA on the fly's X-chromosome and is intensively involved in finding the relevant gene transcript within this interval.

Research in Susumu Tonegawa's laboratory focuses on the molecular, cellular, and neuronal ensemble mechanisms underlying learning and memory and associated cognitive functions of rodents. Their primary approach is to produce genetically engineered mice and analyze them with multifaceted approaches including molecular and cellular biology, histochemistry, electrophysiology of neuronal culture or brain slices, fluorescence-based microscopy, multielectrode physiology of awake animals and behavioral tasks. They have recently generated a new strain of mouse in which the NMDA-type glutamate receptor is specifically knocked out in the CA1 pyramidal cells of the hippocampus. Analyses of these mutant mice have shown that the function of a single protein (i.e., NMDA receptor) in a single type of neuron plays a crucial role in the acquisition of memory. In another study, we have shown that using a transgenic strategy that a hormone-like protein called brain-derived neurotrophic factor regulates the postnatal development of animals' visual functions.

Research in Matthew Wilson's lab addresses the question of how memories are formed and maintained within the mammalian nervous system. Of particular interest is the possible role of sleep in the long-term establishment of memory. By studying the interactions between brain areas using simultaneous neural recording techniques, they are pursuing the flow of mnemonic information during awake and sleep states between brain areas involved in memory formation and areas involved in higher-level cognition and decision making. They have recently found direct evidence of dreaming in rodents by identifying the reactivation during REM sleep of memory patterns established during recent awake experience.

FACULTY HONORS AND AWARDS

Earl Miller received the Troland Research Award from the National Academy of Sciences and the Society for Neuroscience Young Investigator Award. Elly Nedivi holds the Fred and Carol Middleton Career Development Chair.

More information about the Center for Learning and Memory can be found on the World Wide Web at http://web.mit.edu/clm/.

Susumu Tonegawa

GEORGE R. HARRISON SPECTROSCOPY LABORATORY

The George Russell Harrison Spectroscopy Laboratory is engaged in research in the field of modern optics and spectroscopy for the purpose of furthering fundamental knowledge of atoms and molecules and pursuing advanced engineering and biomedical applications. Professor Michael S. Feld is Director; Professor Jeffrey I. Steinfeld and Dr. Ramachandra R. Dasari are Associate Directors. An Interdepartmental Laboratory, the Spectroscopy Laboratory encourages participation and collaboration among researchers in various disciplines of science and engineering. Professors Moungi G. Bawendi, Feld, Robert W. Field, Daniel Kleppner, Stephen J. Lippard, Keith A. Nelson, Steinfeld, Toyoichi Tanaka, Steven R. Tannenbaum and Dr. Dasari are core investigators.

The Laboratory operates two laser resource facilities. The MIT Laser Biomedical Research Center (LBRC), a Biotechnology Resource Center of the National Institutes of Health, develops basic scientific understanding, new techniques and technology for advanced biomedical applications of lasers; core, collaborative and outside research are conducted. The National Science Foundation-supported MIT Laser Research Facility (LRF) provides resources for core research programs in the physical sciences for 13 MIT Chemistry and Physics faculty. Information about the equipment and facilities of the LRF and the LBRC can be found in the Spectroscopy Laboratory Researcher's Guide.

RESEARCH HIGHLIGHTS

Professor Field and his associates have predicted and observed the spectroscopic signature of "local-bender" states in the first singlet electronic excited state of C2H2. These studies will permit direct sampling of the region of the isomerization barrier between acetylene and vinylidene, thus promote systematic characterization of the lowest vibrational "levels" (10^-12 second lifetime) of vinylidene. They were also able to disentangle overlapping spectral patterns in the Dispersed Florescence Spectrum of 13C2H2, from which they could construct a complete description of the intramolecular vibrational redistribution processes. Using a hybrid robust estimator/least squares baseline removal routine devised by Dr. Matthew Jacobson, the Dispersed Florescence spectrum may be recovered, free of corruption by the underlying collisionally-generated baseline. Another ongoing project, a collaboration with Dr. Stephen Coy, involves kinetic modelling of K-changing collisional processes in the acetylene S_1 state. Another major project, conducted by Dr. Manjula Canagaratna and others, is to characterize the structure and nonradiative dynamics of the triplet electronic states in acetylene and to gain insight into radiationless relaxation mechanisms in small polyatomic molecules. Surface-electron-ejection-by-laser-excited-metastables (SEELEM) and laser-induced fluorescence (LIF) are the detection techniques used in this project. A second-generation experimental apparatus, which consists of a doubly-differentially pumped molecular beam machine, has recently been put into operation.

Professors Field and Steinfeld, in collaboration with Drs. Shengfu Yang, Manjula Canagaratna, and Alexander Kachanov, have used IntraCavity Laser Absorption Spectroscopy (ICLAS) and made careful measurement of line intensities and self-broadening coefficients in the oxygen A-band, showing that ICLAS can be a reliable method for obtaining these parameters for weakly absorbing transitions. Measurements have also been carried out on the $3\nu_1$ overtone band of HONO, an important atmospheric trace species. Using a double-time-correlated ICLAS technique, we have succeeded in detecting photolysis products resulting from the flash-decomposition of acrylonitrile.

Professor Bawendi and Drs. Robert Neuhauser and Hans-Jurgen Eisler have designed and developed an apparatus for the highly parallel study of the spectroscopy of individual quantum dots. This allows hundreds of dots to be observed simultaneously in both image and spectral mode. A correlation between fluorescence intermittency and spectral diffusion was observed. Fluorescence polarization studies showed that far-field polarization microscopy can determine the 3 dimensional orientation of individual quantum dots.

Professor Mildred Dresselhaus and Drs. Gene Dresselhaus, Katrin Kneipp, Paola Corio, Alessandra Marucci, and Ado Jorio Vasconcelos have used resonance Raman spectroscopy to study the different characteristic Raman lineshapes associated with metallic or semiconducting carbon nanotubes. The use of surface enhanced Raman spectroscopy techniques was shown to increase the Raman signal by many orders of magnitude. Polarization studies allowed the assignment of the Raman mode symmetries. Further experiments are now in progress to characterize the depolarization effect in metallic carbon nanotubes.

Professor Feld and Drs. Dasari and Chung-Chieh Yu have investigated the effect of having more than one atom at a time present in the cavity on cavity-QED laser by using quantum trajectory simulations. They also have developed a novel apparatus for measuring the degree of second-order coherence g2(t) of the microlaser output. Data for the correlation time is compared with theoretical predictions.

Professors Tanaka and Feld have demonstrated that frustrations of interactions within collapsed polymer gel structures were shown to have been successfully diminished through a synthesis method we call imprinting. UV and fluorescence spectroscopy showed the polymers created in this way were indeed memorizing an aspect of their conformation. This constitutes an important step in the creation of artificial proteins.

Professor Stephen J. Lippard and Dr. Yuji Mikata have developed an efficient method for photocross-linking between cisplatin-modified DNA and damage-recognition proteins using the laser as an irradiation source. There was non DNA-DAN interstrand cross-linking, which had been found upon irradiation with a transilluminator at 302 nm. In another project, Professor Lippard and his associates have used resonance Raman spectroscopy to characterize the interaction of dioxygen and hydrogen peroxide with diiron(II) complexes. The diiron(II) compounds have been synthesized as models for the active sites of dioygen-activating metalloenzymes including hemerythrin, methane monooxygenase, alkane desaturases and ribonucleotide reductase.

Drs. Jayanti Pande and Eugene Hanlon are investigating the role of individual cysteine residues of the eye lens protein γB crystallin, on the oxidation, aggregation and phase separation properties of the protein. Raman spectra of several recombinant γBcrystallin mutants, each with a single point mutation of Cys to Ser suggest that the wild type and mutant proteins are closely similar in their secondary structure and in the environment of thiol groups.

Professor Tannenbaum and Drs. Paul Skipper, Can Özbal and Dasari have further developed a method using ultrasensitive HPLC with laser-induced fluorescence detection. Preliminary epidemiological experiments quantifying benzo[a]pyrene adducts in human plasma have shown that the consumption of meat products may be a possible source of exposure to this carcinogen.

Professor Jonathan King and Drs. Stephen Raso and Hanlon are using Raman spectroscopy to monitor conformational changes in the protein granulocyte-colony stimulating factor (G-CSF) by monitoring changes in the SH stretch and amides I and III. G-CSF is an important therapeutic agent, but drug delivery is hampered by the protein's propensity to precipitate under physiological conditions.

Professor Alexander Rich and Drs. Bernard Brown and Hanlon have used solution-state Raman spectroscopy to observe the left-handed Z conformation of RNAs complexed with the Zα domain of the human RNA editing enzyme ADAR1. These experiments have conclusively demonstrated that the Zα peptide binds RNA molecules in a Z-conformation-dependent manner.

The Tokmakoff group has designed and built a cavity-dumped Ti:sapphire laser capable of producing light pulses as short as 15 femtoseconds. The laser has been used to observe the short time dynamics of liquids such as carbon disulfide, acetonitrile, and water through time-resolved coherent Raman spectroscopy. Work has begun to fabricate a multipass amplifier and OPA capable of generating femtosecond mid-IR pulses, which will be used to investigate vibrational dynamics of liquids and proteins in solution.

Professor Feld and Drs. Dasari, Georgakoudi, Gurjar, Hanlon, Itzkan, Perelman, and Wax are pursuing basic and applied applications of lasers and spectroscopy in biology and medicine. Fluorescence, reflectance, near-IR Raman, and light scattering spectroscopy and low coherence interferometry are being used for histological and biochemical analysis of tissues and diagnosis of disease. Clinical studies are being conducted with researchers from the Cleveland Clinic Foundation, Brigham and Women's Hospital, Metrowest Hospital, Beth Israel Hospital and New England Medical Center. Recent developments include: new technique for extracting undistorted tissue fluorescence using combination of fluorescence and reflectance; development of light scattering spectroscopy-based functional imaging system to detect the precancerous changes in epithelial tissues; development of phase dispersion microscopy and tomography which are based on two-wavelength low coherence interferometric measurements; and fluorescence spectroscopy of brain tissue to identify Alzheimer's disease. The experimental and theoretical work of this program is advancing new laser diagnostic technologies in the field of medicine.

More information about the laboratory can be found on the World Wide Web at http://web.mit.edu/spectroscopy/.

Michael S. Feld

GEORGE R. WALLACE, JR., ASTROPHYSICAL OBSERVATORY

The George R. Wallace, Jr., Astrophysical Observatory (WAO) is a teaching and research observatory located in Westford, Massachusetts. Professor James Elliot '65 is the Director, Dr. David Osip '89 serves as the Assistant Director/Manager, and Mr. Richard Meserole is the Observatory Technical Specialist. Other staff (usually students) are coordinated through research programs. Undergraduates working on the various projects are funded in part by NSF's Research Experiences for Undergraduates (REU) program and in part by NASA and NSF research grants to Prof. Elliot and Dr. Osip. Observing facilities consist of a 24-inch reflecting telescope and a 16-inch reflecting telescope, a 4 bay shed with roll-off roof housing three Celestron 14-inch Cassegrain telescopes as well as a 5.5-inch astrograph, and several Celestron 8-inch Cassegrain portable telescopes. Additional infrastructure includes a building housing electronics workshop, data analysis computer facilities, and observers' quarters. The primary instrument for the 24-inch telescope has been a portable high-speed CCD camera system [PCCD] mated to a custom optics box providing 5:1 field compression at the Cassegrain focus. All other telescopes are equipped with CCD (charge-coupled device) camera systems and dedicated control computers. Additional instruments used during the past year include several photographic cameras, and a high-resolution spectrograph.

A major facility upgrade is currently underway at WAO. Dr. Osip and Richard Meserole are modifying and implementing a new telescope control system known as MOVE (designed originally at Lowell Observatory). As part of this process, the entire telescope has been disassembled for the first time since it was built 30 years ago. All components are being thoroughly cleaned, stripped and painted. The only operating parts of the existing telescope drive that are being kept are the main worm gears for the Right Ascension and Declination axes. These gears have been cleaned, inspected and re-packed with grease. New close-looped encoded stepper-servo motors are being mated to custom 10:1 reduction gearing for both axes. This new drive system will allow full computer control of all telescope motions tracking at both sidereal and non-sidereal (for solar system objects) rates with positional accuracy of better than 0.1 arcseconds. While the telescope is being worked on, the primary and secondary mirror will be tested, polished and re-coated; they will be re-installed in the newly completed telescope by the end of the summer. This year, PCCD has been integrated with the 16-inch telescope during this major upgrade of the 24-inch facilities.

Last year, course 8.287J-12.410J (Observational Techniques of Optical Astronomy) drew eight students, who used the Wallace facilities for a variety of astronomical projects, including broadband imaging of star clusters to construct color-magnitude diagrams and moderate temporal resolution photometric imaging of asteroid light curves to deduce rotational characteristics. For subject 12S23/12.409 (Observing the Stars and Planets, the first subject number distinguishes first-year from upper-class registrants), an additional 23 students used the Observatory for laboratory work. Our planned IAP tour was unfortunately cancelled due to weather, however, more than two dozen students were able to take part in a night of observations that we hosted with MIT Students for the Exploration and Development of Space (SEDS).

Professor Elliot and Steve McDonald '84 have completed a project of high astrometric quality image scans of the star fields through which Pluto and Neptune's moon Triton will cross over the next decade, using PCCD at the 24-inch. The astrometric data have been used to identify stars that will be occulted by these two bodies and quantitatively assess where the occultation path will be visible on the Earth so that necessary observing campaigns can be planned. The eventual occultation data will be used to investigate how the thin nitrogen atmospheres of Pluto and Triton respond to changes in season and distance from the sun. This has been a long-term project carried out by several summer UROP and REU students with supervision provided by graduate student, Michael Person '94 as well as Professor Elliot, Steve McDonald, and Dr. Osip. Results of these occultation candidate searches for both Pluto and Triton have recently been published in the *Astronomical Journal.*

Dr. Osip and UROP student Aletta Wallace '03 along with colleagues at Lowell Observatory are developing a modular telescope and instrument control system to be used by MIT's MAGIC CCD camera for the Magellan telescopes in Chile, of which MIT has a 10% share of the observing time. Current plans are to use Wallace Astrophysical Observatory as a local test-bed for MAGIC implementation prior to bringing the camera to Chile.

More information can be found at the URL http://web.mit.edu/wallace/.

David J. Osip

EXPERIMENTAL STUDY GROUP

ESG continues to provide a fine system of personalized instruction for first year students at MIT. However, we have become increasingly involved in looking at ways to expand ESG beyond strictly a first year program. This is due to the fact that for years we have observed that the people who most benefit from ESG are students who remain involved with the program as teachers, mentors, and students in their upperclass years. Over ESG's 30 year history, it has served a much wider constituency at MIT than first year students. For example, this year the ESG community included not only 64 first year students, but also 12 staff members, 31 student instructors, 11 student mentors (who served as informal advisors to our first year students), 5 student employees, 8 alumni, and 42 upperclassmen who took one or more subjects in ESG during one or two terms. We would like to expand ESG to more closely approximate a "college" within the Institute by offering more subjects of interest to upperclassmen and involving more alumni and faculty in our teaching and learning community.

STUDENT STATISTICS

Sixty-four first year students enrolled for one or both terms in ESG. Fifty-five percent of students were female, eleven percent were international students, and six percent were underrepresented minorities. Twenty-two upperclassmen who had been in ESG as freshmen took one or two subjects in ESG, and 20 undergraduates who had not previously been in ESG enrolled in seminars or HASS subjects taught in ESG. In addition, 31 undergraduate teaching assistants worked closely with our staff in helping out with instruction at ESG. These undergraduates (who collectively maintained a grade point average of 4.4) were closely supervised by staff through a variety of methods, including participating in a weekly teaching seminar in the fall term and meeting regularly with staff members. In addition, student instructors were given feedback from end of term freshman evaluations and from Dr. Sweet's interviews with first year students conducted throughout the fall term.

STAFF AND FACULTY

ESG's administration was headed by Professor Travis Merritt, and included Associate Directors Dr. Peter Dourmashkin and Dr. Holly Sweet. We are pleased to announce the promotion of Julie Banda to Program Coordinator in January 2000. The physics staff included Professor Emeritus Robert Hulsizer, Dr. Peter Dourmashkin, David Custer '82, and Benjamin Davis '99. The mathematics staff was headed by Craig Watkins and included graduate students Pramod Achar and Jessica Young. The chemistry and biology offerings at ESG were supervised by Dr. Patricia Christie. ESG also offered several HASS and HASS-D courses to its students. In the fall term, Professor Merritt taught 21L004. Major Poets and David Custer taught 21W730 Expository Writing. Dr. Lee Perlman taught 24.00, Problems in Philosophy in the fall term and 24.200 Ancient Philosophy in the spring term.

ACADEMIC INITIATIVES AND FUTURE DEVELOPMENTS

ESG continued its long-standing tradition of educational innovation in a variety of ways this year. Benjamin Davis '99 (a former ESG student and last year's winner of the Todd Anderson teaching award) was chosen to head UTEACH, an Institute-wide training program for undergraduates who wish to teach at MIT and elsewhere. Mr. Davis recruited 15 students to teach new subjects during IAP 2000. He also ran a new undergraduate seminar on Game Theory in the spring term. Mr. Davis and Mr. Custer helped develop a new approach to Physics I and II which incorporates engineering applications. We will continue to support these new approaches because they offer a much-needed hands-on design element to first year students. We are in the process of building an electronics lab at ESG which we hope will encourage a community of upperclass electrical engineers to coalesce at ESG. Several new seminars were offered at ESG, including two hands-on seminars taught in residence halls in Spring 2000 with financial support from the Edgerton Center. Dr. Christie taught a seminar on Kitchen Chemistry at Bexley Hall, and Mr. Davis taught a seminar on Robotics at Random Hall. Both subjects were very well received and will be taught again next year in new residences. In addition, Dr. Perlman taught a six unit seminar which will serve as a prototype for a HASS-D subject merging humanistic and scientific thought. Dr. Dourmashkin taught a new six unit seminar on the works of Leonardo DaVinci. Dr. Sweet and Professor Merritt team-taught a freshman advising seminar (Transitions and Connections: Psychology Looks at the Freshman Year), with a view to expanding this seminar to include more freshmen in future years. Part of the seminar will be used in the coming year to help train graduate student advisors to work more effectively with undergraduates in the residence halls. This current year, we initiated an ESG UROP program with funds from the UROP office and have three students involved in UROP projects, including one in philosophy and two in mechanical engineering.

ALUMNI INVOLVEMENT

This year, we began a large-scale effort to engage our alumni in more aspects of ESG, including mentoring our first year students, teaching subjects in ESG, and funding educational initiatives at ESG (particularly those which are run

or developed by students). We held a well-attended homecoming celebration in October of 1999 for all current and past ESG students and staff to celebrate ESG's 30th birthday and to take a collective look at three decades of alternative education. Out of this celebration arose several new ways in which alumni could become involved in ESG. These included participating in a monthly steering committee (chaired by Glenn Iba '74), developing an ESG alumni web site and directory, teaching in ESG (Robert DeMarrais '70, Robert Macke '96, Glenn Iba '74, and Grant Harris '80 all taught subjects at ESG during IAP 2000), and John Ankcorn '74 informally tutored 6.001 to several ESG students in Spring 2000, and funding different projects at ESG. These projects ranged from annual student awards and new community activities to innovative, hands-on seminars.

AWARDS

Sarah McDougal '01, a student mentor in ESG as well as a student instructor, won an Institute Stewart award, in part for her dedicated service to the ESG community over the past three years. ESG gave its own set of awards, including a new award, the Peter and Sharon Fiekowsky community award. This award is funded by Peter Fiekowsky '77 (an alumnus of ESG) on an annual basis and is given to students in ESG who have demonstrated outstanding or sustained contributions to the ESG community. Winners this year included James Rising '03, Toh NeWin '02, Nirav Shah '01, and seniors Caprice Gray and Jesse Wodin. The annual Todd Anderson teaching award (now in its third year) is funded by former ESG chemistry staff member and MIT alumnus Todd Anderson and is given to undergraduates who have demonstrated excellence in teaching at ESG over a sustained period of time. This year's winners included seniors Alicia Jillian Hardy, Jessica Kleiss, and Connie Lu.

FUTURE PLANS

In the coming year we plan to continue with our educational innovation (especially in strengthening our vertical dimension and offering hands-on education, intersdisciplinary subjects, and residence-based seminars), and to promote the use of undergraduates in instructional capacities at MIT. We expect to expand the use of alumni in ESG, particularly in terms of funding new projects and informally tutoring and mentoring our new students. We will be collaborating more closely with other undergraduate programs at MIT, including Concourse, the Integrated Studies Program, and the Media and Arts Program. We look forward to continuing to provide a unique place where staff, students, faculty, and alumni can come together to experiment with new ways of teaching and learning within a collaborative, intergenerational, and interdisciplinary community.

More information about the Experimental Study Group can be found on the World Wide Web at http://web.mit.edu/esg/www/home.html.

Peter Dourmashkin, Travis Merrit, Holly Sweet

LABORATORY FOR NUCLEAR SCIENCE

The Laboratory for Nuclear Science (LNS) provides support for research by faculty and research staff members in the fields of high energy and nuclear physics. These activities include those at the Bates Linear Accelerator Center and in the Center for Theoretical Physics. Almost half of the faculty in the Department of Physics conduct their research through LNS. During fiscal year 2000, the Department of Energy is expected to provide LNS a total of $27,608,000 in research funding.

EXPERIMENTAL HIGH ENERGY PHYSICS

LNS researchers in experimental high energy physics are active at a number of laboratories around the world, including CERN (Switzerland), SLAC (California), and Fermilab (Illinois). The overall objective of current research in high energy physics is to test as precisely as possible the Standard Model, which has been very successful in describing a wide variety of phenomena, and to look explicitly for physics beyond the Standard Model. LNS researchers are playing leading roles in much of this research, as described below.

The L3 experiment at CERN is the largest of four detectors at the Large Electron Positron (LEP) Collider, which is the highest energy such collider in the world. The aim of the experiment is to deepen our knowledge of the Standard Model by measuring with high precision the properties of the intermediate vector bosons, Z and W, their couplings to other particles and, perhaps, the mechanism of spontaneous symmetry breaking. One of course always keeps open the possibility of finding new phenomena beyond the Standard Model. This project has been led from the beginning by an LNS group. Important recent L3 tests of the Standard Model include precise measurements of the properties of the Z^0 particle (the carrier of the neutral electroweak force); demonstration, by two independent methods, that there are only three types of light neutrinos in the Universe; limits on the possible mass of the Higgs boson; and the measurement of the strong coupling constant α. After a number of years of operation at the maximal Z^0 production energy, LEP is now running at energies high enough to produce large numbers of the $W^{\pm}$ particle, the carrier of the charged electroweak force, and possibly to reveal the existence of the Higgs boson.

LNS researchers have played leading roles in exploiting the unique properties of the SLD detector at SLAC, which has now completed its data-taking. Final data analysis is underway. The BaBar experiment on the SLAC B-Factory is now taking data, with the expectation that important insights into the nature of charge symmetry/parity violation will soon be forthcoming.

The Collider Detector Facility (CDF) Experiment at Fermilab is designed to study the Standard Model and its possible extensions at the highest energy accelerator in the world, the Tevatron $\bar{p} - p$ collider. A recent highlight of the project was the discovery of the top (t) quark, by far the most massive elementary particle ever seen. The MIT group played an important role in the data acquisition and analysis which led to this result. Current objectives of CDF include studies of the b quark, the low mass partner of the t quark; precision measurement of the mass of the W; and the search for possible quark sub-structure. CDF is now completing major upgrades (including a time-of-flight system led by the LNS group) and Run II of the Tevatron will begin in 2001.

An experiment to search for the axion, a particle predicted to exist as a minimal extension of the theory of strong interactions as well as a possible solution to the "dark matter" problem in cosmology, is now providing a precise scan of possible axion energies. This experiment is the first to search for the axion in a physically interesting region with sufficient sensitivity to mean a discovery is plausible. A major upgrade of the axion search experiment has recently been approved.

LNS is involved in both large detector initiatives at the Large Hadron Collider (LHC) project at CERN, viz., the CMS and ATLAS detectors. In CMS, LNS scientists are engaged in the development of the data acquisition system; in ATLAS the effort is mainly in the development of the muon detection systems. LNS scientists have considerable expertise in both data acquisition and muon detection systems and expect to be major participants in the U.S. projects at the LHC. Our efforts on the LHC experiments are now growing rapidly.

The Alpha Magnetic Spectrometer (AMS) experiment had a very successful first flight on the Space Shuttle Discovery in June 1998. AMS is an experiment designed to look for cosmic anti-matter and evidence for dark matter by operating a large magnetic spectrometer above the Earth's atmosphere. The international AMS collaboration is

composed primarily of particle physicists and is led by an LNS group. The 10-day mission on Discovery in 1998 was designed to shake down important aspects of this challenging project. The mission accomplished all of its objectives, and provided intriguing new data on the energy spectra of cosmic rays as well. The AMS experiment is scheduled for a 3-year data-taking period on the International Space Station starting in 2003.

EXPERIMENTAL NUCLEAR PHYSICS

Experimental nuclear physics at present has two main thrusts: medium-energy physics and heavy-ion physics. LNS has active, leading groups in both of these sub-fields.

The focus of LNS medium-energy activities is of course the Bates Linear Accelerator Center, which is operated by LNS for the Department of Energy as a national user facility. Bates has been a premier national and international resource for nuclear and particle physics studies for more than two decades. A major upgrade of its capabilities, the South Hall Ring, has recently been completed. This upgrade allows both external and internal-target experiments using the continuous (as opposed to pulsed) beam from the Ring. The continuous nature of the beam is critical for a number of experiments, such as those using coincidence techniques. The opportunity to pursue internal target experiments, especially those involving polarized beams and polarized targets, maintains a unique and important position for Bates in the international community. A new detector (BLAST) for internal target experiments is now under construction.

In addition to the new capabilities provided by the South Hall Ring, Bates has recently constructed major new detectors. For example, the Out-of-Plane Spectrometer allows unique measurements of kinematic correlations of outgoing reaction products. These new experimental capabilities, coupled with ongoing improvements in accelerator operation, provide an unprecedented opportunity to address critical issues in nuclear physics. Also, the SAMPLE experiment has used the unique capabilities at Bates to provide crucial information on the structure of the proton.

LNS nuclear physics researchers are leading several important efforts at accelerator facilities other than Bates. These facilities include TJNAF (Virginia), LANSCE (New Mexico), DESY (Germany), and Mainz (Germany). The project at DESY is an experiment to study the spin structure of neutrons and protons, using among other targets a polarized ^{3}He target constructed at MIT. The first few years of data-taking have been notably successful and a recent detector upgrade is providing important new coincidence data. LNS researchers have also led the design and construction of detectors for experiments at other facilities, such as TJNAF. Our programs at TJNAF are now producing precise new data for a variety of reactions.

LNS has a major role in the field of heavy-ion physics. In recent years the emphasis has been on studies of relativistic interactions of heavy-ion projectiles, especially as they may shed light on the question of the existence and properties of the so-called "quark-gluon plasma." This new state of matter is predicted to exist at temperatures and densities higher than those present in normal nuclear matter, which may be present for a brief time in collisions of heavy ions. An LNS group leads the PHOBOS experiment on the Relativistic Heavy Ion Collider (RHIC) at Brookhaven. First beam-beam collisions have recently been observed, and this exciting experimental program is now underway.

THEORETICAL NUCLEAR AND PARTICLE PHYSICS

Research at the Center for Theoretical Physics (CTP) seeks to extend and unify our understanding of the fundamental constituents of matter and the theory that governs them. In addition, it uses our present knowledge of this theory to advance our understanding of a variety of subjects, including the structure and interactions of hadrons and nuclei, new forms of matter which may be created experimentally or observed astrophysically, and the behavior of the early universe. A few examples of recent work are mentioned below.

String theory aims to unite the strong, electroweak, and gravitational interactions and to explain the observed hierarchy of particles and interactions. The CTP has recently expanded its efforts in string theory with the addition of two new faculty members in this field. Important work includes the study of extended objects known as "branes" that connect string theory with field theories, the exploration of matrix quantum mechanics which may be the fundamental structure that unifies various versions of string theory, and the study of tantalizing connections between string theories in anti-de-Sitter space and conformal quantum field theories.

String theories suggest patterns of supersymmetry breaking which may have implications for physics at the energy scales of the next accelerators. CTP researchers have been exploring these patterns. Also, string theory and quantum gravity suggest that space-time may have other dimensions, which influence physical phenomena only indirectly. Their effects would be manifest in the properties of the "superpartners" of ordinary particles, whose patterns and signatures have been explored by CTP researchers.

MIT theorists have been actively developing new calculational tools for the study of non-perturbative effects in quantum field theories. Variational methods, consistent with renormalization and adapted for easy numerical computation, have been developed and are being applied to problems that arise in the Standard Model.

A major thrust in the CTP has been in the area of lattice gauge theory, which provides a unique tool to solve, rather than model, quantum field theories beyond perturbation theory. Recent advances have centered on new algorithms for implementing non-Abelian gauge theories on a lattice, and for studying systems with finite density. A collaboration to develop a high speed computing facility has been initiated between the CTP, the Jefferson Lab, and several European universities. These efforts parallel a new thrust in the study of quantum chromodynamics (QCD) at finite density and pressure. CTP researchers have suggested novel effects, such as "color superconductivity," and explained how they may be observed in heavy ion collisions.

CTP researchers continue to lead the exploration of the spin and flavor structure of hadrons, as seen in experiments (many led by MIT faculty) at Bates, Jefferson Lab, and DESY.

EDUCATION

Since its founding LNS has placed education at the forefront of its goals. At present approximately 87 graduate students are receiving their training through LNS research programs. A number of undergraduate students are also heavily involved in LNS research. Evidence shows that LNS educates a significant portion of the leaders of nuclear and high-energy physics in this country and abroad.

Robert P. Redwine

CENTER FOR CANCER RESEARCH

The Center for Cancer Research was established in 1973 to study fundamental biological processes related to cancer. The goals of the center's research can be generally stated as developing an understanding of the genetic and molecular basis of cancer, how alterations in cellular processes affect cell growth and behavior, and how the immune system develops and recognizes antigens. These goals are related to the center's major research programs in oncogenes and mammalian genetics, molecular, cellular and developmental biology, and immunology. Approximately 234 people work in the center, distributed among the research laboratories of 13 faculty. In addition, six faculty members in the Whitehead Institute, five in Biology, one in Chemistry and one in the Division of Bioengineering and Environmental Health are Affiliate Members of the CCR.

Financial support for research in the center comes from many sources. The core of this support, which provides much of the funds for administration, partial faculty salary support, and central research facilities (i.e. glass washing facility, specialized laboratories and partial support for new faculty), is a Center Core grant from the National Cancer Institute. The current term extends to April 30, 2005. In addition to the core grant, the center's faculty have a total of 35 fully funded projects (plus >$665,000 of competitive support in fellowships for postgraduate studies). This support comes largely from the National Institutes of Health and the Howard Hughes Medical Institute, from industry, and from a variety of foundations supporting research in particular disease areas (American Cancer Society, Hereditary Disease Foundation, Muscular Dystrophy Association, National Neurofibromatosis Foundation, etc.). This latter type of support is particularly valuable for starting projects which later mature into federally funded grants. The center's success in attracting grant support is a reflection of the excellence of the research and educational activities of its faculty members. The fiscal year 2000 research volume was approximately $11.9 million, which does not include $3.75 million in additional support from the Howard Hughes Medical Institute.

Several groups in the center study the identities and functions of oncogenes and tumor suppressor genes. This work includes the recent identification of two genes disposing to acute myeloid leukemia as well as basic molecular studies on other oncogenes and tumor suppressor genes that regulate gene expression controlling the cell cycle and tumor growth. Another focus is on the biochemical mechanisms controlling RNA transcription and splicing, including studies of genes of the AIDS virus, HIV.

The immunologists in the center study the development of cytotoxic and helper T lymphocytes, their antigen-specific receptors, and the molecular mechanisms of antigen presentation as well as the development and memory properties of B lymphocytes which produce antibodies. Since the immune response to tumors is poorly understood, these basic studies are crucial to a more profound analysis of tumor rejection. Immune cells can destroy cancer cells and it may be possible to stimulate this process.

The cell biologists study cell surface proteins involved in cellular adhesion and migration, as well as cytoskeletal proteins involved in cell motility and shape. Alterations in cell adhesion proteins contribute to the malignant phenotype of tumor cells including involvement in invasion, metastasis and angiogenesis. These proteins as well as cytoskeletal proteins are important targets for antitumor drugs, and deeper understanding of their structure and function should contribute to better therapeutic agents.

Since the cellular processes of development and cancer have much in common, useful insights into the behavior of tumor cells can be obtained from studies of normal embryos; several projects in the center focus on developmental processes. Recent advances in the generation of transgenic mice and mice with mutations in targeted genes are being exploited to investigate the roles of a variety of proteins important in tumorigenesis, including oncogene proteins, tumor suppressor genes, cell adhesion receptors, T-cell receptors and protein kinases.

Major recent research advances include:

- The Jacks lab has developed several invaluable mouse models for cancer, including two which undergo metastasis.
- The Hynes lab has used genomic analyses to uncover genes that control crucial cellular processes in metastasis.
- The Chen lab has developed procedures for analyzing memory T cells, the cells that control immune responses and are the basis for immunization.
- The Hopkins lab has developed a new system to identify genes critical for development in the zebrafish, a genetically tractable vertebrate, and is using this system for rapid isolation of such altered genes.

In addition to its strengths in basic research, the CCR performs an important role in training future researchers in biomedical science, including undergraduate and graduate students, postdoctoral and clinical fellows. The center's faculty fulfills critical roles in the educational programs of the Department of Biology. Extensive collaborations exist with medical schools, hospitals and the biotechnology/pharmaceutical industries. Thus, the research in the CCR has a major impact both on the fundamental understanding of cancer and on translation to and from the clinical arena.

A major strength of the center remains its attractiveness as an environment for the training of young scientists. The center has 51 graduate and undergraduate students and 69 postdoctoral fellows/associates.

It is a pleasure to report the following honors and awards to faculty of the center during this past year. Angelika Amon was named an Assistant Investigator of the Howard Hughes Medical Institute. Richard Hynes was named President of the American Society for Cell Biology. And Phillip Sharp was appointed Director of the newly formed McGovern Institute.

More information about the Center for Cancer Research can be found on the World Wide Web at http://web.mit.edu/ccrhq/www/.

Richard O. Hynes

CENTER FOR SPACE RESEARCH

CSR conducts active research in astronomy, astrophysics, space science, space engineering and related technology, and participates in various National Aeronautical and Space Administration (NASA) flight missions. Specific areas of research include gravity-wave, X-ray, optical, radio, and radar astronomy; theoretical and experimental space plasma physics; planetary surfaces and atmospheres; and the space life sciences. CSR is heavily involved in several ongoing or upcoming NASA missions and supports MIT participation in several major research facilities. Research conducted in CSR is reported by the departments of Physics, Earth Atmospheric and Planetary Sciences, and Aeronautics and Astronautics.

HIGHLIGHTS

The Chandra X-ray Observatory (CXO) a major NASA mission of the "great observatory" series, was launched in July 1999. Two of its four scientific instruments were built at CSR, the High-Energy Transmission Grating Spectrometer (HETG) (Prof. C. Canizares, Drs. D. Dewey, K. Flanagan, M. Schattenburg, P. Ogle, J. Lee) and ACIS, a Charge-Coupled Device (CCD) imaging spectrometer (Drs. G. Ricker, M. Bautz, F. Baganoff, P. Ford, C. Grant, S. Kissel, W. Mayer, G. Prigozhin). Both are operating well. CSR is also active in the Chandra X-ray Observatory Science Center (CXC), which oversees the operation of CXO (Prof. C. Canizares, Drs. G. Allen, D. Davis, J. Houck, D. Huenemoerder, H. Marshall, D. Schultz, M. Wise).

The ACIS team has obtained high-resolution images of a variety of sources. Highlights to date include: detection of a X-ray source of remarkably low luminosity at position of the Galactic Center; detection of X-ray emission from distant (redshift $1< z < 3$), gravitationally-lensed galaxies; and possible detection of X-ray variability in a gravitationally-lensed quasar. (Professors Bradt, Canizares, Schechter and Rappaport; Drs. Baganoff, Bautz, Ricker)

The HETG/CXC team has obtained the first high resolution X-ray spectra of several stellar coronae, supernova remnants (SNR), X-ray binaries and active galactic nuclei (AGN). Highlights include measures of the expansion velocities in an oxygen rich SNR and a probe of the ionized gas surrounding a massive black hole in an AGN. Chandra observations detected X-rays from two recent supernovae, one of them within weeks of the explosion. (Professor W. Lewin)

The orbiting Bruno B. Rossi X-ray Timing Explorer (RXTE), named in honor of the late MIT professor, continues to obtain exciting results in its fifth year of operations. The All-Sky Monitor (ASM, built at CSR) records the long-term intensity variations in some 100 cosmic X-ray sources, mostly binary star systems containing a neutron star or black hole. Some other sources are at the centers of galaxies and are thought to be massive black holes. Multiple instruments have been used to conduct detailed studies of transient binary systems containing a neutron star or a black hole to probe effects of General Relativity, to probe regions of intense magnetic fields, and to understand binary star evolution. (Professor H. Bradt, D. Chakrabarty, S. Rappaport, Drs. Levine, E. Morgan, R. Remillard, W. Cui) RXTE discovered iron line emission with variable redshift from a binary indicating emission from the innermost stable orbit around a maximally rotating Kerr black hole. (Prof. W. Lewin) CSR's CCD X-ray detectors (developed in collaboration with Lincoln Laboratory) continue to operate well on the Japanese ASCA satellite and similar detectors were delivered to Japan for integration into the Astro-E mission, which unfortunately was lost during launch. (Mr. Foster; Drs. Bautz, Doty, Kissel and Ricker)

In radio astronomy, Professor J. Hewitt's program (with Professor P. Schechter) has resulted in one, and perhaps as many as three, new gravitational lenses. Also, a new measurement of the distance to a lens system is one more contribution to world-wide efforts to constrain cosmological models. Hewitt and colleagues at Haystack Observatory have joined a collaboration to develop a large low-frequency array, which will also serve as a prototype for the future Square Kilometer Array. A scientific goal of the MIT group is the mapping of the first structures in neutral hydrogen that formed in the universe after recombination. Professor V. Kaspi continues participating in a very successful survey of radio pulsars that has already found 400 new pulsars in the southern Galactic plane.

MIT is a member of the Magellan Project consortium, which is building two 6.5-meter diameter optical telescopes on Cerro Las Camapanas in Northern Chile, the first being completed next year. MIT and Harvard are collaborating on building a camera to be permanently mounted on the first telescope. Also MIT is collaborating with Carnegie to build the facility guiders. (Professors C. Canizares, J. Elliot, P. Schechter and G. Sussman; Dr. D. Osip, E. Boughan)

The interplanetary plasma group monitors solar wind conditions from three spacecraft, two near Earth (IMP 8 and WIND) and one over 60 Astronomical Units away (Voyager 2) in the outer solar system (Professor J. Belcher, Drs. A. Lazarus, J. Richardson, M. Aellig, Ms. K. Paularena). These satellites continue monitoring "space weather" events, such as Coronal Mass Ejections, which can affect satellites, terrestrial communications and electric power grids.

During the past year, the Laser Altimeter Instrument (MOLA) aboard the Mars Global Surveyor orbiter has continued its nearly continuous observations of echoes from the surface or, where they are sufficiently dense, clouds above the surface of Mars. Professor G. Pettengill and Dr. P. Ford have assembled a statistical description of the occurrence and morphology of the polar clouds as a function of the Martian season. Of particular interest is the observation of the transport velocity of individual storms.

The MIT/Caltech Laser Interferometer Gravitational-wave Observatory (LIGO) project is well into the commissioning phase, and coincidence measurements between the sites in Hanford, Washington and Livingston, Louisiana are planned for 2001. The first optical resonant cavities over kilometer baselines were operated in late 1999, and the characterization of the lasers, optics, and mechanical systems is underway at both sites. In parallel, the international LIGO Science Collaboration has developed algorithms for data analysis, and advanced plans for a next generation interferometer. (Professor R. Weiss, Drs. P. Fritschel, D. Shoemaker, M. Zucker)

Theoretical investigations include: supercomputer simulations of large scale structure in the universe (Professor E. Bertschinger), the hydrodynamics of binary star coalescence and dynamics of dense star clusters and work on the origins and dynamical evolution of extrasolar planetary systems (Professor F. Rasio); studies of the evolutionary histories of collapsed stars (white dwarfs, neutron stars, and black holes) in binary systems, including cataclysmic variables, low mass X-ray binaries, binary millisecond pulsars, and the effects of binary membership on supernovae (Professor S. Rappaport and P. Joss); and studies of the X-ray halo of the galaxy Hercules A (Professor P. Morrison). Closer to Earth, a new innovative theory of multiscale intermittent turbulence based on the idea of forced and/or self-organized criticality and Topological Phase Transitions has been developed for the description of the Earth's magnetopause magnetotail and auroral plasma dynamics. (Dr. T. Chang)

MIT participates in NASA's National Space Biomedical Research Institute; Prof. L. Young is the first Director and leads a major new research initiative in artificial gravity, and Dr. C. Oman leads NSBRI programs in the Neurovestibular area. Data analysis continues from the neurolab experiments on STS90 and the Enhanced Dynamics Load Sensor experiment flown on MIR. (Dr. C. Oman, Prof. D. Newman)

UPCOMING PROGRAMS

The High Energy Transient Experiment (HETE), a small satellite being built at CSR to search for gamma ray burst sources, is ready for launch. (Drs. G. Ricker, J. Doty, R. Vanderspeck, G. Crew, J. Villasenor)
Periodic nano-structures fabricated for use as UV filters were launched in January 2000 on the Magnetopause to Aurora Global Exploration (MENA) mission, and similar devices are being prepared for the TWINS missions to follow in 2002 and 2004. (Dr. Schattenburg) An instrument to continuously monitor solar wind ions every on the TRIANA satellite was delivered and is being tested. (Dr. A. Lazarus, J. Richardson) Experiments are being prepared for the International Space Station, including the MICRO-G project to provide advanced force and moment sensors and a virtual reality experiment (Profs. L. Young and D. Newman, Dr. C. Oman) and science leadership for a cell culture unit. (Dr. G. Vunjak-Novakovic) Work on advanced X-ray optics, ultra-smooth reflection gratings and advanced X-ray CCD's continues. Potential applications include NASA's future Constellation X-ray and MAXIM missions. (Professor C. Canizares, Drs. G. Ricker, M. Bautz, M. Schattenburg, G. Prigozhin, S. Kissel)

More information about this center can be found on the World Wide Web at http://space.mit.edu/.

Claude R. Canizares

CHAIR OF THE FACULTY

FACULTY POLICY COMMITTEE

This year, the Faculty Policy Committee (FPC) oversaw those aspects of educational and academic policy that are specific responsibilities of the Faculty and provided faculty input toward policy development at the Institute. The committee met twice with President Vest, twice with Chancellor Bacow, and several times with Provost Brown. The FPC used these opportunities to convey faculty opinions on a variety of topics including institutional partnerships, policies on intellectual property and outside professional activities, undergraduate life and learning, and campus planning. The FPC Subcommittee on Exam and Term Regulations continued its work from last year and brought forward recommended changes to the regulations, which were approved at the April Faculty Meeting. The FPC approved three proposed degree programs — one S.B. program, an S.M. program, and an M.Eng. program—which were forwarded to the Faculty for a vote. The FPC also heard from and coordinated the work of the other Faculty committees.

Subcommittee On Examination And Term Regulations

In Spring 1998, the FPC Subcommittee on Examination and Term Regulations, chaired by Professor Donald Sadoway, began a review of Faculty regulations governing the administration of quizzes, tests, and examinations during the term and those pertaining to the beginning and end of term. The subcommittee reported regularly to the FPC during the 1998–99 and 1999–2000 academic years and submitted its final report in March 2000. In the report, which can be found on the World Wide Web at http://web.mit.edu/faculty/reports/exam-termregs/, the subcommittee recommended that:

- presentation of the class syllabus take place in the first week of the term, rather than the third;
- evening exam rules be clarified, particularly the hours during which the exams may be given;
- testing during the last week of classes be eliminated, and tests that would have been scheduled for that week be shifted to the final exam period; and
- *ex camera* (out-of-room) final exams be introduced as a new mode of testing.

The recommendations resulted in revisions to Sections 2.10 and 2.50 of *Rules and Regulations of the Faculty,* which were presented to the Faculty at its March meeting and approved at the April meeting. The revised regulations took effect on July 1, 2000. The subcommittee also made recommendations with regard to governance, violations, informing faculty members of regulations, and recursion. Another subcommittee will be charged with conducting a similar review of the regulations governing graduate subjects with the intention of recommending revisions by Spring 2001.

Communication Requirement

In February, the FPC heard the final report of CUP Subcommittee on the Communication Requirement, and Professor Suzanne Flynn, chair of the CUP, conveyed the CUP's endorsement of the subcommittee's recommendations. As part of its final report, which can be found on the World Wide Web at http://web.mit.edu/faculty/reports/communication/, the subcommittee articulated a set of general principles for the new Communication Requirement:

- instructionally based programs in both writing and speaking housed in academic departments will replace the current competency-based Writing Requirement housed in the central administration;
- Communication-intensive (CI) subjects will usually include practice in both writing and speaking;
- the Communication Requirement should not add subjects to an already overly burdened undergraduate curriculum;
- students will normally take one CI subject in each of their undergraduate years;
- Fall entering students will be required to demonstrate competency in expository writing upon entrance through the Online Freshman Essay Evaluation or an equivalent test; and
- MIT will provide additional resources to support the new requirement.

The FPC endorsed the proposed requirement, which was presented to the Faculty at its meeting in February and approved in March. The Communication Requirement will go into effect beginning with the Class of 2005, which will enter MIT in the fall of 2001. A subcommittee of the CUP will oversee the implementation and monitoring of this new requirement.

Subcommittee On Institutional Partnerships

In response to concern over faculty input into the establishment and administration of institutional partnerships, the FPC established a subcommittee to serve as a consultative body to the senior administration on new strategic partnerships. The Subcommittee on Institutional Partnerships will provide a mechanism for the Faculty to be

involved in the discussions before MIT makes a contractual commitment that obligates the faculty and students. The subcommittee is charged with reviewing the Institute's ongoing partnerships and determining the goals, benefits, and costs of these relationships. The group will be informed of any ongoing or future negotiations, even if confidential, and members may be asked to enter into nondisclosure agreements during the period in which an agreement is under negotiation. Members of the subcommittee will be appointed by the Faculty Chair for staggered three-year terms and will include the Faculty Chair (ex officio), six other faculty members (only some of whom need be FPC members), and a research staff member; two students members—an undergraduate and a graduate student—will serve one-year terms.

Intellectual Property Policies
Over the course of the academic year, the FPC met several times to discuss intellectual property issues. In meetings with the Provost and the Vice President and Dean for Research, FPC members urged the administration to clarify policies regarding intellectual property, licensing, and conflict of interest, particularly in light of new technologies affecting the development and delivery of educational materials. The FPC will continue to be engaged in discussions on these matters through the coming academic year.

New Degrees Programs
During the 1999–2000 academic year, the FPC approved proposals to establish several degree programs: a new S.B. degree in Physics, an S.M. in Bioengineering, and an M.Eng. in Biomedical Engineering. After receiving the endorsement of the FPC, these proposals were presented and approved by the Faculty.

COMMITTEE ON THE UNDERGRADUATE PROGRAM

The Educational Design Project, charged by the Committee on the Undergraduate Program (CUP) and co-chaired by Professors Kip Hodges and Stephen Benton, submitted its preliminary findings and recommendations in August 1999. The report found that "the current curriculum does not do enough to sustain student enthusiasm for learning or to leverage upon their enthusiasm and sense of academic direction to achieve better educational results." These findings established the theme for the committee's summer retreat and were the inspiration for this year's call for proposals for curriculum development support through the d'Arbeloff Grant funds. In addition, the report was the catalyst for discussions at three meetings among members during the fall term that resulted in the development of a formal statement from the CUP outlining the goals of the First Year at MIT.

In October, Professor Jean Jackson presented to the CUP the final report of the HASS Overview Committee (HOC). The HOC had been asked to review an experiment, begun in September 1995, that had allowed a regrouping of the HASS-D Requirement to incorporate the Visual and Performing Arts into one of the required categories. The CUP approved the recommendation that the HASS-D Requirement be simplified so that students would be required to take three subjects from three different categories, but without further constraint. Ultimately, the following language was approved by the Faculty: "To satisfy the HASS-D Requirement, students must take three subjects selected from three of the five HASS-D categories. Alternately, students may take two subjects from two categories and a Level III or IV foreign language subject."

In October, the CUP engaged in preliminary discussions about charging a review of Pass/No Record grading and AP credit. Professor Charles Stewart was asked to chair a subcommittee, and a charge was prepared in late November. Professor Stewart presented the preliminary findings to the CUP in April; a final report with recommendations will be presented in the fall of 2000.

Members of the Subcommittee on the Communication Requirement visited the CUP on several occasions. In November, the committee heard the results of an experiment that modified the Writing Requirement by adding an additional component at entrance and altering slightly the Freshman Essay Evaluation. In December and, again, in January, the final report and recommendations of the subcommittee were presented. The CUP endorsed the general spirit of the report—i.e., that the Writing Requirement be replaced by a Communication Requirement effective with the freshman class entering in Fall 2001—and forwarded the recommendations to the FPC. A charge is being prepared that appoints a permanent subcommittee of the CUP to oversee the Communication Requirement and its implementation.

The CUP approved a proposal by Professor Kip Hodges to extend the freshman credit limit for his new freshman-specific offering for the Fall 2000 semester. "Mission 2004" is a 9-unit subject designed to explore the feasibility of a new freshman requirement in multidisciplinary, project-based learning; students enrolling in this subject will be allowed to exceed the first-year credit limit by 3 units. Professor Hodges also asked for and received approval for the subject to satisfy Phase 1 of the Writing Requirement; this approval will be in effect for at least the first year of the subject.

Committee business in also included:

- The CUP met with Professor Edward Crawley to discuss the process undertaken by the department of Aeronautics and Astronautics in the past few years to review the undergraduate curriculum and develop a new educational model of Conceiving-Designing-Implementing-Operating (CDIO) systems and products.
- The CUP heard a report from Professor Hal Abelson about the structure and vision of the new Council on Educational Technology.
- The CUP discussed with the Chancellor the search for a new Dean for Undergraduate Education and met with Professor Redwine at its final meeting of the year.
- The CUP heard and approved the proposals for a new S.B. degree in Physics and an M.Eng. degree in Biomedical Engineering and forwarded both to the FPC.
- Members of the newly formed Premedical Advising Council discussed with the CUP plans for new approaches to premedical advising.
- The committee reviewed and rejected a proposal from the Academic Resource Center to extend the freshman credit limit for students who take both a Freshman Advising Seminar and 6.001.
- Professor John VanderSande, Director of the new Cambridge-MIT Institute, visited CUP in April to review plans for the program and, in particular, the undergraduate student exchange.
- CUP heard and approved a proposal from Architecture to establish a student exchange program between MIT and the Delft University of Technology. Discussion of this proposal stimulated members' interest in improving the quality of information and advising about undergraduate study-abroad opportunities as well as in developing more such possibilities for our students.

OTHER FACULTY COMMITTEE REPORTS

Professor Paola Rizzoli continued to chair the Committee on Academic Performance (CAP) during the 1999–2000 academic year and, in this capacity, served on the FPC Subcommittee on Examination and Term Regulations. The CAP acted on a total of 547 petitions during the year, an increase of less than 2 percent from the previous year. Of this total, approximately 232 were reviewed administratively by the chair. As noticed in the previous year, the revised Incomplete policy has been very effective in reducing the total number of petitions.

Of continued concern is the number of petitions falling under the category of "administrative neglect," i.e., petitions for late adds/drops. In 1995–96, these petitions accounted for 29 percent of the total number. This number rose to 40 percent in 1998–99 and continued to increase in 1999–2000 to account for 42 percent of the total number of petitions received. Also of concern is the number of petitions submitted by students to exceed their Warning credit limit, which has more than doubled since last year in spite of the hard line taken by the CAP on such requests

The number of petitions (47) for late registration due to financial hold is still high, although slightly less than last year (54). In cooperation with the offices of Student Financial Services (SFS) and Counseling and Support Services (CSS), the CAP established a procedure to tighten the financial hold policy. In the future, the written recommendation of a committee formed by three members of SFS and CSS is required for the CAP to consider petitions for retroactive registration for the previous semester.

The CAP has taken action to improve the reporting mechanism for the grade of *Incomplete*. The previous Instructor's Report form was often submitted with insufficient information and did not allow for a default grade should a grade not be obtained by the student's graduation date—a situation that occurred frequently. A new Instructor's Report form has been developed to address these issues.

CAP actions voted at the end-of-term meetings resulted in 381 Warnings, the same as in the previous year; and in 36 Required Withdrawals (RW), down 20 percent from last year. A possible reason for the decrease in number of RWs is the increase in the number of withdrawals due to medical reasons.

The summary of CAP actions taken on undergraduates in 1999–2000 is:

Year	Warning	Required Withdrawals
Freshmen	133	5
Sophomores	107	0
Juniors	72	10
Seniors	69	11
Totals:	381	36

The Academic Progress Group, formed in Fall 1998, completed its study of freshmen who receive warnings or required withdrawls. A report comprising two parts was presented by the CAP chair to the Faculty Policy Committee. Part I looks at predictors of academic difficulties in the freshmen year, and Part II examines the trajectory of this group of students, identifying the best predictors of the trajectory.

During the first meeting of 1999–2000, the Committee on Corporate Relations (CCR) and Director of Corporate Relations Karl F. Koster reviewed the activities that had been conducted during the preceding year. This set the stage for the two areas on which CCR focused: implementation of the OCR Faculty Liaison Plan and the campaign to raise funds for graduate student fellowships.

The Faculty Liaison Plan was launched formally in January 2000 with the goals of communicating to the faculty the mission of the Office of Corporate Relations, including the Industrial Liaison Program (ILP) and Corporate Development; increasing the number and range of faculty members working with industry by helping junior faculty make contacts through the ILP and ensuring that faculty can connect easily with member firms; systematically tracking the interests and expertise of the faculty in order to facilitate the dissemination of that information to the corporate community, as appropriate; and helping to identify potential funding contacts for research from ILP members and other companies.

To accomplish these objectives, an OCR Officer has been assigned to work with each School and department. To introduce the plan to the faculty, a new OCR *Guide for MIT Faculty and Staff* was developed and distributed to all faculty and staff members. Each Dean and department head was provided with an expanded version of the *Guide,* which included a listing of 1999 corporate support to MIT departments.

At the CCR meeting on April 26, OCR provided an update of work done to initiate a "mini-campaign" for corporate support of graduate fellowships. To learn of best practices from Departments that have corporate fellowship support already, and ascertain the interest of the department head in working with OCR to raise funds for this purpose, interviews have been conducted with the heads of 10 departments in the Schools of Engineering, Science, and Architecture and Planning.

The Committee on Curricula (COC) met 14 times during the 1999–2000 academic year. The Committee approved proposals for new, canceled, and revised subjects, and reviewed student petitions for substitutions to the General Institute Requirements, as well as approving substantive curricular changes and upholding policy.

The COC approved the following: a new S.B. in Physics, Course VIII-B; a request from Foreign Languages and Literatures to approve an exception to the minor requirements; minor changes to the undergraduate curricula in Aeronautics and Astronautics, Economics, Political Science, Physics, and Mechanical Engineering; and changes to the Core subjects in Mathematics and Chemistry.

Effective of March 3, 2000, the Committee implemented a policy limiting the number of S.B. degrees to two, which it approved the previous year.

The Committee on Discipline (COD) heard charges against eight students this year. Seven charges were for academic misconduct, and one was for personal misconduct. Three other charges for academic misconduct remain to be heard during the summer. In addition, one charge was dropped, while another was investigated and determined to be unfounded. The sanctions for the charges of academic misconduct were varied, ranging from informal probation, to formal probation with a notation marked on the student's transcript, to the withholding of a degree. The sanction for the charge of personal misconduct was suspension from the Institute for one and a half years. The COD also reviewed a number of petitions involving the removal of disciplinary notations from transcripts.

As in the past, the COD, in conjunction with the Office of the Dean of Students and Undergraduate Education, reported on disciplinary actions at Faculty meetings. Committee members hope that this practice alerts faculty members to the need for consistent reporting of incidents to the COD or the Dean's Office so that students become more aware of the ramifications of engaging in academic dishonesty.

This year, the Harold E. Edgerton Award Selection Committee reviewed 15 nominations for the award, which is given to an outstanding member of MIT's junior faculty. After careful deliberation, the committee decided to award the honor to L. (Maha) Mahadevan, an associate professor in the Department of Mechanical Engineering who holds the Karl van Tassel Career Development Chair. He works in "classical nonlinear physics" and is distinguished by

the range of peculiarly arresting topics that have attracted his attention — topics that raise issues in mechanics and physics, mathematics, and biophysics, and have applications in a still more extended set of specialties. He was also cited for his contributions as a teacher of MIT undergraduate and graduate students, and, through his carefully crafted contributions to journals such as *Science* and *Nature*, of a broader public audience.

The Committee on Faculty-Administration (CFA) continued its focus on issues arising at the time of faculty retirement and beyond. During the 1998–99 academic year, the committee's focus was on clarification of Institute policies and faculty choices regarding retirement, and the appointment of emeritus faculty as Professor Without Tenure, Retired. In 1999–2000, this work was extended to include a review of services provided to retired faculty who do not hold such appointments. The purpose of the review was to gain an improved understanding of the ways that faculty relate to the Institute after retirement and to seek ways to increase the dignity attached to emeritus status as a contribution to retirement incentives and faculty renewal. In cooperation with the Provost's Office, a detailed survey was carried out of Schools and departments concerning faculty behavior at end of career. Based on the committee's analysis of these data, a memorandum was prepared for the Provost and Chancellor summarizing the current situation regarding services to retired faculty and recommended additions to these services.

Also, pursuing a recommendation by the 1998 Task Force on Student Life and Learning, which suggested strengthening faculty governance by streamlining its committee structure, the CFA carried out a review of both Faculty committees and committees to which faculty members are appointed by the President and the Corporation. This effort led to a recommendation to the Provost and Chancellor of small changes in the procedure for managing committees appointed by the President and Corporation. The changes would clarify the roles of these committees for the benefit of faculty and remove some faculty obligations that may no longer be needed.

The committee to select the James R Killian, Jr. Faculty Achievement Award for 2000–01 had a number of meetings during the last academic year. Its conclusion, announced at the May meeting of the Faculty, was to present the 2000–01 Killian Award to Professor Jerome Friedman, Institute Professor and Professor of Physics, noting his very distinguished intellectual contributions to the field of physics and his outstanding abilities as a teacher, mentor, and colleague. The committee also welcomed the greater continuity provided by the implementation of the membership overlap of one of its members from one year to the next.

The Committee on the Library System (CLS) met seven times during the 1999–2000 academic year. After reviewing the state of the MIT Libraries, the committee concluded that the system is facing serious issues. The central issues are long-term underfunding of the library system, space master planning for the Libraries, and technology planning for the MIT system. Problems facing MIT's Libraries include: the inadequacies of much of the Libraries' physical space; MIT's library staff are paid one-third less than their counterparts at peer institutions; MIT spends less than one-third as much per student on libraries as Stanford; and the Institute's libraries house one-third of the collection in off-campus storage owing to lack of on-campus space, placing MIT in the bottom quartile among its peer institutions. At the same time, MIT's heavily used collections are focused on the most expensive category of literature—science and technology—and the continuing growth of information technology adds to the Libraries' cost of operation. The CLS members identified these issues as requiring serious attention and have recommended a substantial increase in MIT's investment in its library system.

The Nominations Committee worked to develop a slate for the Standing Committees of the Faculty, replacing members whose terms had expired. In addition, the committee nominated Professor Jeffrey H. Shapiro to serve as Chair-elect of the Faculty. The committee emphasized identifying newly tenured faculty for committee slots, in the interest of introducing these colleagues to faculty governance. Emphasis was also place on offering opportunities to faculty members who had not served previously or recently. The committee's slate was presented to the Faculty at the April meeting and approved without dissent at the May meeting.

During the 1999–2000 academic year, the Committee on Outside Professional Activities considered distance learning, first discussing some of the patterns currently in use both at MIT and elsewhere, and, then, expanding discussion to include issues relating to conflict of interest. The committee plans to continue its discussions of distance learning in the next academic year.

The Committee on Student Affairs (CSA) met on 12 occasions during the 1999–2000 academic year. Early in the term, the meetings focused on how to engage the Faculty more effectively in student life outside the classroom/laboratory and student life programming issues. Professor Paul Gray provided important retrospective insights to the committee, which were supplemented by interviews with Deans Margaret Bates, Katherine O'Dair,

and Andrew Eisenmann, and Special Assistant to the Chancellor, Dr. Kirk Kolenbrander. In addition, the committee was updated on current capital projects by Ms. Victoria Sirianni, Director of Facilities, and reviewed the dining plan with Mr. Richard Berlin, Director of Dining.

During the second semester, a shift of direction for the committee came about as a result of the Strategic Advisory Committee's (SAC) report to Chancellor Bacow. The Unified Proposal for the Residence System, which was commissioned by the Chancellor, revealed shortcomings in student governance structures as perceived by the students on the SAC. The report proposed the establishment of a Student Life Council with a purview that overlapped with that of the existing Committee on Student Affairs. To eliminate the possibility of redundant responsibilities, the Chancellor asked the CSA to consider the SAC proposal for a Student Life Council and conduct a self-assessment. The result was a unanimous proposal for a revised Committee on Student Affairs; the committee intends to present a motion to re-charter the CSA to the Faculty in the fall of 2000.

During 1999–2000, the Committee on Undergraduate Admissions and Financial Aid (CUAFA) conducted a comprehensive review of the admissions process during 1999–2000, which was prompted by a large turnover in committee membership. The committee endorsed the procedures of the Admissions Office, which was judged to be fully competent and highly efficient, especially in the light of the dramatic increases in the numbers of applicants over the past several years without concomitant increases in staff. However, committee members agreed that a greater degree of faculty involvement is desirable and, to this end CUAFA, took steps to encourage greater participation by faculty in the entire admissions process. The result was the highest level of faculty participation in recent years, both in reading admissions folders and deciding whom to admit (so-called Roundup). This effort to involve faculty will be continued next year.

To a lesser extent, the operations of financial aid were studied by committee members. CUAFA discussed the growing level of merit aid being offered by other schools and the impact of this trend on MIT's ability to attract the best students. CUAFA reaffirms MIT's policy of need-blind admissions and need-based financial aid. However, CUAFA is uneasy about the growing cost disparity (now estimated to be in excess of $5000 per year) between MIT and its peer institutions. This has been further exacerbated by the decision on the part of some schools to exclude home equity when calculating of the family contribution. Accordingly, CUAFA supported the Dean's Office request for a substantial increase in the amount of money allocated to financial aid by MIT.

In the coming year, CUAFA plans to confer with the newly appointed Director of Student Financial Services and her staff to develop a long-range strategy for MIT financial aid. Paramount in these discussions will be concerns over accessibility in the light of shifting demographics and quality, i.e., what effects the changing financial aid climate in the country are likely to have on the Institute's continued ability to attract the best students. Also, CUAFA will take up the question of recruiting, i.e., what can be done to ensure that our applicant pool is richly stocked with students who are traditionally hard to attract to MIT.

The Committee on the Writing Requirement (CWR) was established by a vote of the Faculty in the spring of 1982 to oversee the undergraduate Writing Requirement. On March 15, 2000, the Faculty voted to replace the Writing Requirement with a new comprehensive Communication Requirement overseen by a subcommittee of the CUP. Consequently, 18 years after its creation, the Committee on the Writing Requirement is discharged by the Faculty, effective June 15, 2000. Members of the CWR supported the establishment of this new requirement and new governance structure. The committee is proud of its role in helping to develop this new curriculum that will provide all MIT undergraduates with substantial and sustained instruction and practice in writing and speaking.

During the final year of its existence, the CWR reviewed and endorsed the CUP Subcommittee's proposal for the new Communication Requirement prior to the proposal being presented to the full CUP, the FPC, and the Faculty. The CWR also focused on activities to aid in the transition to the new Communication Requirement. First, a special subcommittee, constituted of CWR members and faculty from the School of Humanities and Social Science, evaluated the administration and efficacy of the online Freshman Essay Evaluation (FEE). After reviewing random sample essays and responses from over 30 freshman advisors, the subcommittee concluded that the online FEE was overall a valid and reliable instrument for assessing the writing abilities of entering students. The subcommittee did suggest several minor procedural changes, which have been implemented already.

The CWR also administered the two-year experiment, mandated by the CUP, requiring students receiving the score of *Subject Required* on the FEE to take a specified expository writing subject during their first year at the Institute. These students displayed significant problems in their ability to write clear and effective prose that are most sensibly

addressed by an intensive writing subject early in their academic careers. The faculty of the Program in Writing and Humanistic Studies, Foreign Languages and Literatures, and Literature, aided by a special grant from the Chancellor, staffed an unprecedented number of sections, ensuring places both for students who were required to take one of these classes and others who simply wanted to improve their writing skills.

During the summer of 1999, the CWR formed a working group composed of Professors Winston Markey and Langley Keyes, Dean Bonnie Walters of the Office of Academic Services, Dr. Leslie Perelman and Ms. Madeline Brown of the Writing Requirement Office, and Ms. Jane Dunphy of the English as a Second Language Program. This group developed a straightforward and comprehensible procedure for reporting information on the revised Writing Requirement to freshman and their advisors. The committee is happy to report that there is nearly complete student compliance with this new requirement: of the 208 members of the Class of 2004 receiving a score of *Subject Required*, 204 completed a designated expository writing class during the 1999–2000 academic year.

Finally, the Committee compiled its policies and procedures for the governance of the current Writing Requirement as a reference for the new CUP Subcommittee on the Communication Requirement, which will now oversee the administration of the Writing Requirement and the transition to the Communication Requirement.

Sincere appreciation is extended to the following faculty members for their special contributions and service as appointed Chairs of the Standing and Special Faculty Committees during the past year: Paola Rizzoli (Academic Performance), Merton C. Flemings (Corporate Relations), Arthur C. Smith (Curricula), Stephen C. Graves (Discipline), Pauline R. Maier (Edgerton Award), Henry D. Jacoby (Faculty-Administration), Jean P. deMonchaux (Killian Award), John H. Lienhard (Library System), Triantaphyllos R. Akylas (Nominations), William L. Porter (Outside Professional Activities), Candace L. Royer (Student Affairs), Donald R. Sadoway (Undergraduate Admissions and Financial Aid), Suzanne Flynn (Undergraduate Program) and Winston R. Markey (Writing Requirement). Many thanks to Paul T. Matsudaira and Evelynn M. Hammonds for their service as Associate Chair and Secretary of the Faculty.

Steven R. Lerman, Anna Frazer

EXECUTIVE VICE PRESIDENT

This second year of my tenure at MIT marks a kind of completion. Working with colleagues across the campus, I have filled key vacant positions and created and filled new positions necessary to execute the ambitious initiatives of the Institute. Working from experience and with key advisors, I have realigned people into organizational structures which co-locate necessarily related roles and clarify who has authority and responsibility for what.

This second year also marks a kind of beginning. And as I think about the coming years and the transformative campus projects that will redefine community and the built environment of MIT, I keep coming back to one basic question: how to enhance the utility, quality and efficiency of administrative services? Or in the words of Professor Paul Joskow, how to make MIT administration hum.

We are working on a few key themes which, if truly made operational, will change the way we work together. First and foremost is *client orientation.* We need to listen to and understand the service needs of our colleagues in the departments, labs and centers. We have an educational role, as well, to make sure everyone understands our central offices' institutional responsibilities which can sometimes complicate administration. And then we need to work together to resolve problems and streamline processes. Administration is a means to academic ends. We need to remember this every day, and act accordingly.

Administration at MIT is also many silos, reinforced by unintegrated systems and databases. Complex business processes break down when confronted by silo walls. The silos need to come down through cultural exchange programs and development of integrated systems and databases. *Collaboration,* through teamwork, boundary-blind business processes, and open sharing of common information is, thus, our second theme. The emerging framework for the Human Resources/Payroll project is client-oriented and collaborative by design. If successful, it will define our new approach, and integrate five separate unintegrated administrative (software) systems into one. Data and process silos will fall.

As we enter a decade of unprecedented capital construction, with ambitious design standards and heightened aesthetic awareness, we are turning our attention to renewal of MIT's older facilities and the overall attractiveness and cleanliness of the campus. Standards for cleanliness, maintenance, and frequency of facilities renewal are in the making. Rising to higher standards through intention, persistence and judicious allocations of resources is our imminent challenge. Longer term, our challenge is staying the course: *sustainability* is thus our third theme.

Accountability is necessary to hold everything together, but accountability exists only when we measure deviation from standards, obligations, and commitments, and when it is both organizational and personal. A necessary condition for accountability is clarity of roles and responsibilities. A second necessary condition is that we in fact measure and provide the feedback that forces correction at worst, and promotes continuous improvement at best.

Measuring our deviations from local (MIT) standards is not enough. Professional standards and best practices in many areas—from accounting, to audit and risk management, to investment performance, to technological prowess to capital project management—are evolving rapidly. In some areas we need to reach currency; in others, we are leaders. We should strive for leadership across all the professions which define us beyond our roles at MIT. *Professionalism* is the fifth theme.

In subsequent reports to the president, we will present our annual reviews in these thematic terms and measure the extent to which we are making all five operational.

Areas of focus in this past year were:

CAMPUS PLANNING AND DEVELOPMENT

A major focus of this year was establishing the administrative infrastructure that will support the Institute's most ambitious building and renewal program in more than 30 years. Within the Department of Facilities, the management of the Capital Projects Group was reconfigured, and MIT hired both a Director of Capital Development (Deborah Poodry) and a Director of Capital Construction (Paul R. Curley). These two highly qualified staff members are responsible for ensuring that the flow between project development and construction is a coordinated, disciplined, and smooth process.

A related and important aspect of preparing for the increasing volume and complexity of construction and renovation projects was a reorganization of the Planning Office functions. The needs that led me to this decision

included not only integrated management of the construction program but also closer coordination among siting design, permitting, and construction activities that affect the complex and cutting-edge new facilities that MIT will build.

Members of the Planning Office staff were reassigned to align their technical expertise more closely with the departments and business processes that rely on them. Activities that now reside in the Department of Facilities include capital project planning and program development, the campus plan, planning infrastructure, and support to the Building Committee. Planning functions around student residences, enrollment planning, and space issues in the Office of the Deans of Student Life and Undergraduate Education have been moved to that area. Support for academic planning and institutional research has become part of the Provost's Office. Parking issues that formerly were handled in the Planning Office have been moved to the Parking and Transportation Office, which already reported in my area. The former Director continues as Special Advisor to me.

This year saw the coalescence of the Town and Gown team, also known as the TAG team. This group strives to balance academic, investment, and community-relations goals of the Institute and to speak with a consistent MIT voice. I was particularly pleased that the TAG team also has forged working relations with Harvard University's planning and real estate offices as well as its vice president for government relations. Exemplary of its new team approach, a subgroup of TAG orchestrated by Catherine Donaher has worked intensely with the Cambridge Growth Management Advisory Committee and Harvard to assure that institutional zoning interests are balanced with the interests of the City.

The TAG team and the Capital Projects Group in Facilities are currently paving the way for a concerted effort to seek approval from the City of Cambridge for a number of building permits early in the next fiscal year. Broad campus planning efforts continue under my direction and that of the Campus 2000 Steering Committee, with significant input from landscape architects Laurie Olin and Associates.

ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES

In July, the Environmental Programs Office (EPO) was created to take responsibility for overall environmental, health, and safety (EHS) management at the Institute. Jamie Lewis Keith, Managing Director for Environmental Programs and Risk Management and Senior Counsel, heads the EPO. The offices charged with providing services and oversight to the MIT community on EHS issues were reorganized into a single team reporting to Ms. Keith. This reorganization should result in clearer accountability and responsibility for all regulatory programs that govern MIT's work.

Other positive EHS initiatives included the expanded recycling and green procurement effort, the Green Building Task Force, and the discovery process for the EHS management system.

Another change this year was transferring the management function for workers' compensation claims from the Safety Office to the Benefits Office in Human Resources in order to consolidate all injury-related and other paid-leave benefits in one office.

STREAMLINING ADMINISTRATIVE OPERATIONS

Additional important steps were taken in our ongoing effort to streamline administrative operations. For example, the Financial Review and Control team studied existing policies and procedures for financial reconciliation and made recommendations to simplify and improve this process Institute-wide. After testing in several pilot departments, the new procedures will be put in place during the next year.

The Human Resources/Payroll discovery project recommended that MIT implement the HR/Payroll module of SAP, and a core project team has been appointed. The Lincoln Laboratory Fiscal Office has reviewed enterprise resource planning systems to determine their requirements and has evaluated SAP for use at the Laboratory. The opportunity is at hand to collapse five independent systems, which are now necessarily related through complex custom interface programs, into one integrated system.

Planning and budgeting also are becoming more integrated, and the fiscal year 2001 budget was developed through an increasingly open process that is consistent with the 10-year financial model developed with the Executive Committee of the Corporation.

The upgrade to version 4.5b of SAP was successfully completed in November. I was pleased that this upgrade included the participation of community members from departments, labs, and centers who assisted with integration testing and evaluation of training plans.

Work continues on improving our processes for financial reporting. The Data Warehouse came into its own as the source for financial data and analysis. Efforts to create consistency of terminology and data between the Institute's budget and the *Report of the Treasurer* simplified both documents. New reports were developed for MIT's gifts and endowments, details on telephone usage, support for the streamlined reconciliation process, and reports on open purchase orders and requisitions.

The Procurement Office's overall eBusiness strategy has been recognized as a model nationally, and acceptance by MIT's user community has been outstanding. This year saw dramatic increases in the use of the VIP procurement card, the electronic catalog for purchases from partner vendors, and use of SAP/SAPweb (rather than paper) requisitions.

We initiated a project to create a centralized administrative services group for Audio-Visual Services, Campus Police, the Copy Technology Centers, and the Parking and Transportation Office. The goal is to identify, analyze, and consolidate like processes of the four departments that will result in more effective use of technological and human resources.

PERSONNEL
In addition to Ms. Poodry, Mr. Curley, and Ms. Keith, other major appointments this year included Laura Avakian as Vice President for Human Resources, and Deborah Fisher as Institute Auditor. In my office, Sharon Pinksten was hired as my Executive Assistant, and Anna DiMaria joined us as Administrative Assistant supporting Patricia Brady, Stephen Immerman, and Janet Snover

Following are the individual department reports.

John R. Curry

FINANCE

AUDIT DIVISION

The MIT Audit Division continues to deliver audit services through a risk-based program of audit coverage including compliance assessments and financial, operational, and technology reviews and audits. These efforts, in coordination with MIT's external auditors, provide assurance to Institute management and the Audit Committee that policies are being adhered to as intended, adequate internal controls are being maintained, and assets are properly safeguarded.

A key event during the year was a management transition, prompted by the departure of Charles A. Shaw from the position of Institute Auditor at the close of the previous fiscal year. Following this departure Divisional leadership was provided by the Audit Manager and two senior members of the audit staff who comprised a transition team pending placement of a new Institute Auditor. Deborah L. Fisher assumed this position in February 2000. The transition team shared responsibility for daily management and supervision of staff, and notably completion of the audit plan as scheduled in December. It is a tribute to these individuals, and to the high performance standards maintained by the Audit Division as a whole, that audit objectives for 1999 were achieved.

Individual academic, research, and administrative units play an important role in the overall systems of internal control of MIT. Recognizing this, the Audit Division devotes a substantial portion of the audit plan to review of these areas. Audits of financial controls exercised within these units are conducted on a semi-continual basis. During the past year, coverage included the School of Humanities, the Provost's Office, and Offices of Vice President for Research and Dean of Graduate Education, among others. A fairly consistent level of compliance with Institute guidelines for internal control was noted. Additionally, a new program of auditing the administration of sponsored programs commenced with the Chemistry Department and the Division of Comparative Medicine, focusing on compliance with various terms and conditions of contracts and grants.

In similar fashion, the Information Technology audit team has designed a methodology for benchmarking control practices for local area networks (LANs). The initial review was completed for the Media Lab, with five other areas planned for the coming year. Practices in the areas of security, recoverability, reliability and other factors are rated on a three-point scale, with recommendations for improvements of practices where it appears some benefit may accrue.

The Audit Division has made successful use of strategic partnerships with outside audit firms to "co-source" audits of the Treasurer's Office and of a major campus renovation project (Building 33). Plans to continue these relationships will help the Division maintain effective audit coverage, particularly for the large volume of capital construction activity scheduled for the next several years.

The audit team is often called upon to assist management with special reviews or investigations. A powerful combination of audit skills and knowledge of Institute practices resides within the Division, providing an "on-call" resource when the occasion arises. Division personnel also have been valuable contributors to Institute initiatives regarding control improvements. Audit Manager Michael Bowers led the Authorization Process Implementation Team, a group formed to study and recommend an efficient and effective process for maintaining Institute-wide system authorities. The Division also participated in developing revised guidelines for DLC review of financial activity, which will incorporate concepts such as risk-based testing. Involvement in efforts of this nature demonstrate the Audit Division's willingness to foster positive change as part of a management team, in addition to the traditional role of independent assessor.

The theme of audit-as-business-partner will continue in the upcoming year. The new Institute Auditor is a member of the Executive Vice President's Senior Management Team and of the Administrative Systems and Policies Coordinating Council (ASPCC), and other members of the Division function in an advisory capacity to various projects and initiatives Institute-wide. In this way, the Division remains up-to-date with regard to changes taking place and can maintain a clear focus on the risks that confront MIT.

As the year progresses, the audit management team will compare internal administrative practices for audit plan development, audit methodology, and uses of technology, to "best practice" standards, and consider ways in which existing resources can be better leveraged. And, in accordance with long-standing practice, audit personnel pursue professional development opportunities through education and affiliations with industry peers, as well as obtaining of professional certifications.

More information about the division can be found on the World Wide Web at http://web.mit.edu/audiv/www/.

Deborah L. Fisher

FINANCIAL SYSTEMS SERVICES

The Financial System Services department (FSS) coordinates the development, delivery, and maintenance of financial systems for the Institute. Our mission is to support the ongoing implementation of SAP; ensure that the software increasingly meets the needs of departments, laboratories, and centers (DLCs); keep MIT current in terms of installing the appropriate new version of SAP and other related software; and work to further integrate MIT's business processes.

The upgrade to version 4.5 of SAP was successfully completed in November 1999. FSS broadened the testing phase of the new version beyond just the central offices, which had done the testing in the past. With the new release, community members from a variety of DLCs were invited to help with "integration" testing. The purpose was to ensure that simultaneous use of the system across applications would provide stable, predictable, and accurate results.

In response to requests from users, email "event notification" capability was added to SAP in June 2000. Users are now able to receive email messages notifying them of changes to the status of SAP requisitions that they create.

The SAP user group continued to be a valuable forum for communicating with users about new SAP and Data Warehouse capabilities and receiving their comments on anticipated changes. To provide an additional communications vehicle, staff members from FSS, the Controller's Accounting Office, and the Office of the Executive Vice President began publishing the *Financial Systems Update*, a Web-based newsletter with updates on new financial and reporting tools in use at the Institute.

FSS personnel participated on the Financial Review and Control team, an interdepartmental team formed to review existing policies and procedures for financial reconciliation. The team recommended that the Institute reduce requirements for documentation and records retention; develop new tools for review of charges; find a new way to indicate that the review is complete; and allow reviewers to use a risk-based analysis of charges focused on areas where risk of error or loss is greatest.

An initial effort to investigate the use of the SAP Fixed Assets module focused on depreciation processes related to academic buildings and space changes. These processes, formerly handled with spreadsheets and databases, were converted to SAP in the spring of 2000.

The Human Resources/Payroll Discovery Project, completed in March 2000, recommended that the Institute implement the SAP Human Resources/Payroll module. Early planning began in April 2000, and a core project team was appointed in May 2000 to support the planning and startup activities. A formal project kickoff, project announcements, and ramp-up to a full complement of staff are expected in the coming year.

Lincoln Laboratory personnel, with the assistance of FSS, began developing a business case for implementing SAP at Lincoln Lab. The effort focuses on accounting, purchasing, inventory management, plant maintenance, project management, and human resources/payroll. A financial analysis of several implementation alternatives will be performed. The business case, with resources and time lines, will be presented to senior management in late summer 2000. In addition to serving as the replacement for several aging Lincoln Lab systems, the SAP implementation would permit the consolidation of human resources and payroll business operations; allow for joint purchasing opportunities; and build expertise in SAP modules under consideration for future use.

It is anticipated that a routine upgrade to SAP will commence in the fall of 2000 to support the use of SAP components for increased Web capabilities; the upcoming implementation of the SAP HR/Payroll module; electronic commerce; and the expected migration of Lincoln Lab to SAP. This upgrade also will provide the MIT community an improved SAP graphical interface.

SAP's Internet Transaction Server, the backbone for the new modules that comprise SAP's Internet strategy, is being deployed to support the implementation of new human resources/payroll employee self-service and "business-to-business" applications, and to satisfy the community's request that they be able to verify credit card transactions and create journal vouchers on the Web. Development should be ready for central department pilot testing by the end of August 2000.

In July 2000, all FSS personnel will move to building W92 (304 Vassar Street).

Charles A. Shaw

OFFICE OF BUDGET AND FINANCIAL PLANNING

The mission of the Office of Budget and Financial Planning (OBFP) is to support MIT's goal of continued excellence in education and research by providing senior management with accurate and timely financial analyses, projections, and recommendations. The Office is responsible for monitoring the Institute's financial position and the likely impact of anticipated internal and external changes; developing the Institute's strategic financial plan under the leadership of senior management; and managing MIT's planning and budget information through development of innovative budgeting, modeling, and analytic tools. Continuing goals of the Office of Budget and Financial Planning are to oversee the evolution of the budget process to make it more efficient and effective, and to enhance responsiveness to the emerging needs of the Institute. Budget Office leadership and staff work closely with the MIT community in developing and providing resources to manage the Institute's financial assets.

During fiscal year 2000, the Office of Budget and Financial Planning continued its substantial role in supporting long-range planning and the definition of strategic goals at the Institute level. The 10-year planning model, first introduced in 1997, has evolved into a comprehensive financial planning tool that focuses on the long-term financial consequences of strategic investments in programs and facilities. Planning and budgeting are progressively more integrated, and the fiscal year 2001 budget was developed through an increasingly open planning process, consistent with the current 10-year financial model developed with the Executive Committee of the Corporation. The fiscal year 2000 and 2001 budgets were balanced within these parameters, at specific approved levels of additional need for endowment.

In addition, OBFP continues to develop and refine its comprehensive, multi-year capital plan. The capital plan, which is used to manage and analyze funding options for capital needs and to support external borrowing requirements, is integrated with financial planning and is now presented on a recurring basis to the Executive Committee to support resource allocation decisions. The most recent plan shows new construction needs of $861 million, including the Stata Center, the new undergraduate dormitory, and other major projects highlighted in the Financial Plan.

In April, the Office of Budget and Financial Planning published the Budget Book for fiscal year 2001. The Budget Book, published yearly since Fiscal Year 1998, presents the annual operating budget to MIT executive and corporate management. The budget is the culmination of a defined budget development process and provides detailed support for the revenue and expense items reported for Fiscal Year 2001 in the Financial Plan.

In fiscal year 2000, OBFP completed the implementation of the NIMBUS budget system and its successful integration with SAP. NIMBUS, which is the system of record for Institute budgets, maintains and feeds budget information to SAP and the MIT Data Warehouse nightly. The NIMBUS web front end (http://web.mit/budget/nimbus) was operational for the fiscal year 2000 budget cycle. A graphical user interface for maintaining and analyzing budget data was completed in fiscal year 2000. NIMBUS replaced the legacy system, which was not Year-2000 compliant and was inconsistent with the SAP financial architecture.

Significant future plans of the Office of Budget and Financial Planning for fiscal year 2001 include evaluating the use of its systems to support changing pre-submission budget processes for departments, laboratories, centers and central support units. Budget Officers will continue to establish close working partnerships with client units and to serve as focal points for financial information flow. OBFP goals also include ongoing and evolving enhancement of financial, capital planning and resource allocation, management and reporting tools.

Stefano Falconi

OFFICE OF THE CONTROLLER

The Office of the Controller consists of the following groups:

The Controller's Accounting Office provides general accounting services to the Institute including accounts payable, accounts receivable, travel, sponsored research accounting, general ledger, financial reporting, payroll, and retirement plans accounting.

The Procurement Office assists the MIT community in the procurement of goods and services—providing advice and services that ensure favorable prices, protective terms and conditions, and compliance with MIT and federal policies and procedures.

The Property Office responsible for the accounting and asset management of more than 100,000 items of equipment that are both MIT- and sponsor-owned.

The Lincoln Fiscal Office provides accounting, payroll, cashier, cash management, and property control services to MIT's Lincoln Laboratory.

Extensive work on Year 2000 readiness in all of the Controller's Office financial systems paid off in fiscal year 2000, as we successfully crossed the boundary into the year 2000 with no disruption to users. As part of the Year 2000 compliance project, the Lincoln Fiscal Office updated the General Ledger and all systems that feed the General Ledger, and version 3.4.20 of the Lincoln Executive Information System (LINEIS), which was done in partnership with Group 68 (Computer and Telecommunication Systems.)

In other systems projects, we participated in the November 1999 upgrade to the SAP financial software, implemented a new SAP fixed asset accounting module, and worked with Financial Systems Services and the user community on a number of incremental enhancements and improvements to the SAP system. In the SAP procurement module, improvements included: enhancement of the web *Display Purchase Order* function to permit viewing and printing of the entire purchase order; development of an electronic mail purchase order notification system and the capability to fax purchase orders to vendors using SAP, both of which are now in pilot.

Sponsored Research Accounting (SPNA), the unit responsible for funding and financial reporting for all sponsored research contracts and grants, made several enhancements to the SAP sponsored billing process, two of which were major upgrades. One allows us to bill sponsors in advance, based on a negotiated amount and schedule entered into the contract. The other upgrade allows us to transfer systematically, via SAP, revenue drawn through various letter of credit mechanisms to the appropriate WBS project, on a monthly basis.

A Human Resources/Payroll discovery team was formed in collaboration with other relevant MIT organizations, and work began on defining the requirements for a new SAP-based Human Resources/Payroll system. The Lincoln Fiscal Office participated in an enterprise resource planning discovery process at Lincoln Laboratory to determine requirements and evaluate SAP for use at the Laboratory.

We continued streamlining accounting processes and procedures. A team completed the first phase of a project to make detailed definitions of MIT's General Ledger accounts available to users and to eliminate duplicate and unused general ledger accounts. A Financial Review and Control project team was formed to evaluate the current financial statement reconciliation process and develop recommendations for a simplified process, which is now being tested in several pilot departments.

Reporting of MIT financial activities was improved in fiscal year 2000 through development of monthly reports split by type of activity—general, fund, and research. This was an Institute-wide effort that required input from both end users and financial staff. These reports required changes to our financial software as well as to master financial data. Created to help manage MIT, these reports are provided to senior management and will continue to be improved based on management needs.

In addition, the Institute and Enterprise Reporting group, working collaboratively with departmental staff, the Data Warehouse group, and Financial Systems Services developers, continued making enhancements to financial reporting from SAP and the Data Warehouse. New warehouse reports were developed for a variety of purposes, including: reports on MIT's gifts and endowments, detailed reports on telephone usage, reports to support the streamlined reconciliation process, and reports on open purchase orders and requisitions, to name a few.

The Procurement Office was instrumental in developing an overall eBusiness strategy which is fully integrated with SAP, utilizes Web-based technology, and provides a true Business-to-Business front-to-backend eCommerce solution that facilitates the procurement process for the MIT community while helping to achieve MIT's overall procurement strategy. The programs we helped to develop—SAPweb requisitioning, the ECAT electronic catalog, and the VIP procurement card—are state of the art and were recognized this year at higher education and professional meetings, including the international SAP Higher Education User Group, the SAP America User Group, and the National Association of Purchasing Managers.

In Procurement, new temporary help contracts were negotiated with Adecco and Total Clerical Services. In conjunction with the Managing Director for Environment Program's office, Procurement took an active role in promoting recycling and green procurement. In fiscal year 1999, Procurement assumed responsibility for reviewing all Facilities construction orders over $500,000 and all Stata Building orders over $25,000. Organizationally, personnel who support sponsored subcontracts were transferred to the Office of Sponsored Programs, and a team was created in Procurement to deal with the more complex, but non-sponsored procurements. Procurement began working with Facilities on the relocation of the solvent stockroom from the Chemistry building to east campus. Procurement also is currently working closely with Harvard to possibly form a consortium for purchasing commodities such as audiovisual supplies; bottled water; and maintenance, repair and operating supplies.

Acceptance by the user community of the VIP procurement card and other new procurement methods has been outstanding. Paper requisitions were down from approximately 27,500 in fiscal year 1999 to 12,200 in fiscal year 2000. SAP/SAPweb requisitions increased from approximately 20,200 in fiscal year 1999 to 41,500 in fiscal year 2000. There were approximately 24,000 transactions using the new Web-based electronic catalog for partner vendors (ECAT). The VIP card transactions increased to 69,200 in fiscal year 2000 from 28,600 the prior year. Now that implementation of the new procurement systems is complete, distribution of the paper ("blue copy") purchase order was discontinued.

In Travel, three new hotel openings (in Philadelphia, London, and Chicago) were added to the Club Quarters hotel chain contract, which allows MIT travelers to stay in Washington, D.C. and other major cities at significantly reduced rates compared to other hotels. A new contract with greater discounts was negotiated with Delta Airlines, and the Budget Rent-A-Car and Alamo contracts were renegotiated to add government and special rates, respectively.

In the Property Office, the annual indirect cost study for the equipment and building pools was conducted in conjunction with the Office of Cost Analysis. The scanning cycle of the equipment biennial physical inventory was completed and the reconciliation cycle was begun. Fifty-seven capital projects were begun during the year. The costs of capital space changes, major renovations, and new building construction continue to be tracked. Conversion of the building capitalization data from worksheets to the SAP Asset Management module has begun and will be used for the fiscal year 2000 closing.

Retirement Plans Accounting (RPA) is responsible for the accounting and reporting for the MIT Basic Retirement Plan and the MIT Supplemental 401(K) Plan. RPA maintains records for more than 19,000 members (active, terminated with vested rights, retired, and disabled) and disburses retirement benefits. In Retirement Plans

Accounting, major initiatives started in 1999 to meet record keeping requirements of the Basic Plan and outsourcing of the Supplemental (401k) Plan were substantially completed. These included modifying the Pension Accounting system, streamlining administrative processes, and implementing new financial reporting systems and controls to monitor activities of the Supplemental (401k) service. At year end, an investigation of alternatives to MIT's underwriting of Supplemental (401k) annuities was completed, which will provide the basis for annuities to be issued by insurance carrier partners in the future.

The Lincoln Fiscal Office (LFO) supported Lincoln Laboratory in preparing for and obtaining the new Air Force five year contract, through the proposal system that provides five year historical data in order to project expected expenditures for the next five years. LFO also provided support for audits including the Defense Contract Audit Agency auditors' (DCAA) audit of A-133, DS-1, and related operational audits.

This past year the LFO Property Office has complied with new requirements and outstanding requirements from prior periods, specifically in the areas of physical inventories, subcontractor control, financial reporting, fabrication of test equipment as well as the movement, utilization, storage, and disposition of government property. In addition, the DCAA started a special audit of all government property at Lincoln Laboratory that will support the US federal government's financial reporting.

Using the SAP system, fiscal year 1999 closing was successfully completed by July 31, 1999. SAP and related improvements in our closing process reduced the amount of time it took the PricewaterhouseCoopers auditors to complete the annual audit.

In the human resources area, Accounts Payable and the Procurement office participated in a pilot of the new competency-based human resource system.

More information about the Office of the Controller can be found on the World Wide Web at http://web.mit.edu/cao/www/, http://web.mit.edu/purchasing/, and http://web.mit.edu/property/www/.

James L. Morgan

OFFICE OF SPONSORED PROGRAMS

The Office of Sponsored Programs' mission is to conduct the centrally organized administrative, business, and financial functions related to grant and contract administration and to assist faculty, principal investigators, and their administrators in the identification of resources for and the management of individual sponsored projects consistent both with MIT's academic and research policies and with the stewardship requirements of and obligations to external sponsors.

RESEARCH VOLUME

For fiscal year 2000 the total volume of sponsored research performed on campus was $383,988 (all numbers rounded to nearest thousand). This increase of $8 million represents a modest increase of 2.1 percent in total volume compared with the fiscal 1999 volume of $376,047. The breakdown by sponsor is shown in the table below.

Table 1. Campus Research Volume By Sponsor 1990–1999
(in thousands of dollars)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
FEDERAL										
DHHS	59,025	60,177	64,882	60,192	61,066	58,211	57,215	58,938	58,246	65,905
DOE	60,625	57,355	57,325	63,180	67,114	59,588	70,753	70,281	63,138	57,000
DOD	49,104	48,539	66,769	61,601	55,866	59,997	67,858	64,776	65,718	65,686
NSF	37,953	36,574	38,008	39,574	38,564	35,837	36,347	36,264	35,352	35,669
NASA	22,755	25,889	32,324	37,449	41,291	39,190	36,947	30,227	27,301	22,734
Other	8,647	9,773	8,899	8,722	9,641	8,721	7,232	9,115	7,409	6,753
Subtotal	**238,109**	**238,307**	**268,206**	**270,718**	**273,542**	**271,544**	**276,352**	**269,601**	**257,164**	**253,747**
NON-FEDERAL										
Industry	48,360	53,578	62,068	59,117	56,120	67,164	75,194	74,062	74,325	73,609
Nonprofit	23,751	24,920	25,593	23,666	26,430	25,926	28,952	36,197	42,214	50,970
Other	5,599	5,461	5,487	6,173	5,597	5,649	7,382	6,495	2,344	5,662
Subtotal	**77,710**	**83,959**	**93,148**	**88,956**	**88,147**	**98,739**	**111,523**	**116,754**	**118,883**	**130,241**
TOTAL	**315,819**	**322,266**	**361,354**	**359,674**	**361,689**	**370,283**	**387,880**	**386,355**	**376,047**	**383,988**

COMPLIANCE ISSUES

One of the most significant developments over the past year has been the increased focus of federal agencies (particularly the National Institutes of Health) on the issue of compliance. In June 2000, NIH announced a requirement for education on the protection of human research subjects for all investigators who intend to submit competitive NIH applications and for a similar education requirement prior to establishing funds in the Institute's accounting system for non-competing awards. Additionally, during fiscal year 2000, MIT revised its financial conflict of interest policy for individuals with awards or pending proposals at NIH and/or the National Science Foundation (NSF) to require full disclosure of financial interests that meet the NSF/NIH thresholds. For both of these policy changes, the Institute is developing secure Web-based systems to record and track the appropriate information. In addition, the Institute is beginning to develop a Web-based training program for human research subjects, which may be extended to other types of compliance activities.

COSTING ISSUES

The Institute addressed a variety of costing issues during the past fiscal year, ranging from cost sharing and effort reporting policies and issues to negotiation of Facilities & Administrative rates for future years. Items of particular interest are described below.

Cost Sharing and Effort Reporting

The Presidential Review Directive (PRD) report has identified cost sharing and effort reporting as a significant issue with respect to the research efforts of institutions of higher education. With the adoption of changes to OMB Circular A-21 in recent years and the incorporation of cost accounting standards in that document, the emphasis on accountability became, in large measure, on precision of cost accounting, not on research outcomes. The PRD report has clearly stated "The principal measure of accountability must be research outcomes" and has concluded that accountability and accounting are not the same. MIT has been active in working with federal agencies, the Federal Demonstration Partnership, and the National Science and Technology Council (NSTC) in proposing ways that accountability can be achieved with less burdensome administrative and cost accounting requirements.

Negotiation of Facilities and Administrative (F&A) and Employee Benefit Rates

MIT successfully completed negotiations with our cognizant agencies, Defense Contract Audit Agency and Office of Naval Research, to establish F&A rates on a fixed with carryforward basis for fiscal years 2000 and 2001 at 63.5% MTDC (the same rate as for fiscal year 1998 and fiscal year 1999) and on a provisional basis for fiscal year 2002 at 65.5% MTDC. Employee benefit rates were negotiated for fiscal year 2001 at rates which were substantially lower than those rates for fiscal year 1999.

Review of Costs of New Construction

One of the significant A-21 changes in 1998 was the adoption of a review process to ensure the reasonableness of facilities costs for research facilities costing over $10 million, of which 40 percent is expected to be used for federal research. There is a requirement for additional documentation for buildings costing greater than $25 million with more than 50 percent allocated to federal research. MIT has developed a formal process to meet these requirements and has created a standardized template for identifying types of costs and determining the reasonableness of those costs in comparison with appropriate peer data. This process is being utilized for the Stata building and will eventually be used for all new construction at the Institute.

Other Costing Activities

The audit conducted annually as required by OMB Circular A-133 was successfully completed in May 2000 with an unqualified opinion, no identified material weaknesses, and a determination as a low-risk entity.

RESEARCH ASSISTANT COMPENSATION

For fiscal year 2000, MIT adjusted its policy with regard to supporting graduate research assistants, wherein MIT elected to provide support for 65 percent of the academic year tuition for each graduate research assistant and 100 percent of the tuition for the summer semester. Although this changed the distribution of Institute support between stipend and tuition categories, it did not materially change the total support provided by the Institute to graduate research students.

INTERNAL OSP INITIATIVES

Deployment of the post-award component of COEUS continues to departments, laboratories, and centers of this system. This will permit Institute personnel to access the database, and will provide the capability to produce standard and custom reports quickly and independently. The testing phase of MIT's electronic proposal system has been completed, and deployment of the electronic portion of COEUS is currently proceeding. In addition, MIT continues to work with NSF and NIH, and later with other federal agencies, to allow submission of the entire

research proposal in an electronic format to federal agencies. By October 2000, faculty and other researchers may prepare research proposals electronically, and OSP will either send the electronic version to the sponsor, or print the proposal for paper submission. This will enable any researcher at MIT using the technology already available in the researcher's office or laboratory to electronically create research proposals and submit them electronically to federal agencies that can accept the electronic version.

MIT was the first institution to receive electronic awards in a standardized format from ONR and was one of the first institutions to successfully transmit electronic proposals using a standardized EDI format to several federal funding agencies. We are continuing our activities in these areas, with the goal of accepting electronic awards from all federal agencies and establishing accounts for these awards automatically into MIT's computerized database system (COEUS), thus speeding the processing and establishing of awards for faculty and other MIT researchers.

More information about this department can be found on the World Wide Web at http://web.mit.edu/osp/www/.

Julie Norris

OPERATIONS

AUDIO VISUAL SERVICES

Audio Visual Services is dedicated to meeting the Institute's needs for presentation support for a wide variety of activities, including classes, special events, and cultural programs. Through the use of audio, video, and computer projection and amplification systems, the department works with students, faculty, and staff to produce daily classes, seminars, conferences, and concerts, reaching thousands of people each year, both on campus and at remote sites around the world. Over 10,200 individual requests for service were filled this year, resulting in total income over $1,200,000. More than $270,000 of this billing was related to system installations in classrooms.

Supporting the Institute's educational activities comprised 65 percent of the department's work orders in the past year. The operation of audio visual equipment for daily classes and weekly support for seminars and colloquia continue to be the largest area of business for the department. Members of the department perform over 120 calls for service daily during the school year.

Production of special events continues to be another focus of the department. Complex computer projection and audio systems were designed and operated by department technicians for the following events: weekly Media Lab colloquia, Media Lab Sponsor Week, the new student Orientation program, satellite teleconferences hosted by the Enterprise Forum, digital video presentations by NASA astronauts, Commencement 2000, and Technology Day events.

Direct involvement in audio visual systems design for classrooms and lecture halls continued this year. Completed projects include the installation of computer and video projection and sound systems in Rooms 34-101, 2-105, 14E-310, 26-100, E52-175, and 6-120. These installations will allow presenters easy access to projection equipment for computers and other video playback devices. The second phase of the Building 1 classroom renovation project was developed with design input by the department. Four new classrooms will be equipped with presentation technology systems by the beginning of the fall 2000 term.

A major upgrade in distance learning technology in the Bechtel Lecture Hall (1-390) was planned and executed. Members of the department participated to assure that the needs of the local audience and presenters were met. All projection and control equipment has been replaced and a touch screen interface has been designed to allow for a wide variety of media to be displayed both to local and remote audiences. The control system will allow technicians to monitor and control room systems from remote locations, allowing the implantation of a help desk for technology classrooms.

To provide staff with continuing education opportunities, four department staff members attended the 2000 Infocomm International Conference in Anaheim, CA in June. Infocomm is a showcase of communications technologies and a series of workshops designed to inform and educate industry professionals in the latest equipment and procedures to support presentations. As part of Infocomm, two department members participated in a three-day class entitled Facilities Design for Universities. This course will allow the department to take a greater role in the design of systems and facilities for the Institute. Six members of the department attended a local two-day school hosted by Extron Electronics, a manufacturer of computer interfacing equipment. Three technicians attended weeklong training classes at Crestron Electronics in New Jersey. With this training, department staff members will be able to upgrade and create classroom control systems. A weeklong course on Barco computer/video projectors

was taught at MIT to five department staff members, allowing us to perform a higher level of service to the Institute in technology classrooms with this projection equipment. Several members of the department also took advantage of on-campus computer training opportunities held at MIT's Professional Learning Center, becoming better trained in software necessary to operate the department.

Further developments on the department-created workorder database occurred, with the incorporation technician time recording and expanded billing modules. Representatives from Information Systems and the Controller's Accounting Office continued to assist us to make MIT Audio Visual Services a fully compliant Internal Service Provider for the Institute.

Further information about Audio Visual Services can be found on the World Wide Web at http://web.mit.edu/av/.

Louis W. Graham, Jr.

CAMPUS POLICE

The MIT Campus Police continued to commit itself to providing services to the Institute through community policing partnerships that reduce crime, create a safe environment, build trust, and enhance the quality of life in the academic community. The department remains committed to delivering quality service to the community in an effective, responsive, and professional manner.

The number of crimes against persons increased slightly over 1998. The 1999 total was 34 incidents. There were 89 incidents of theft of Institute-owned property compared to 156 in 1998. Computers and computer components were, once again, the most frequent type of Institute-owned property stolen. There were 465 incidents of theft of personal property reported at sites other than residences compared with 256 last year. The majority of items stolen were wallets, laptop computers, and backpacks. We had the same number of thefts occur from inside residences this year as we did in the previous year with a total of 57. Again, the most frequently stolen items were bicycles and electronic equipment. There were 15 motor vehicle thefts this year resulting in a slight increase over the total of 13 in 1998. The theft of bicycles increased with a total of 121 bicycles stolen as compared to 99 stolen in 1998.

Campus Police also supplemented Safe Ride when early morning operations ceased by providing 562 personal safety escorts to members of the community.

The Campus Police department provides 24-hour emergency medical services to all members of the community as well as to Draper Laboratory and the Whitehead Institute.

The total number of patients transported by the Campus Police decreased in 1999 by 33 percent from 1998. The 1999 total was 1,607.

The Rape Aggression Defense (RAD) self-defense program continued to be a popular course. Since the program began in 1994, a total of 488 MIT community members have been trained.

More information about this department, its services, operations and campus crime can be found on the World Wide Web at http://web.mit.edu/cp/www/.

Anne P. Glavin

COPY TECHNOLOGY CENTERS

The goal of this organization is to provide the community with the highest quality copier and copier-related services. We continually strive to maintain a balance of providing new technology at reasonable costs. To achieve success, we pledge to institute creative programs of efficiency and quality controls while maintaining sound business principles. We hold the customer at the center of our efforts and their satisfaction as our mission.

HIGHLIGHTS

The CopyTech Express Center in Building W20 enjoyed a well-received first year of operation. The busy center's popularity has grown steadily because of its extended hours and diverse mix of services. It appears evident that the new center will continue to be a student favorite for "on the run" day or night services.

The Copy Technology Centers were enthusiastically involved in a new initiative to increase Institute participation in recycling and green procurement efforts. Working with various representatives of the MIT community, the group

has made a major impact on the issues of product choices and disposal methods. Our department has welcomed an active role in many of these new initiatives and looks forward to further involvement in the coming year.

The past year has seen significant increases in participation in a number of departmental service programs. The most dramatic involved the following:

- The Cost-Per-Copy Program provides a turn key copy service within Institute departments. Our department installs copiers, performs all service and supplies maintenance, and processes the monthly chargebacks to departmental accounts.
- The Print-On-Demand Program specializes in the scanning and storing of electronic images for demand printing. Customers can provide a source document one time and then request additional reprints or make revisions electronically at their convenience.
- The Conference/Seminar Copy Program provides a complete copy service program to the many Institute conference and seminar events that occur on campus throughout the year.

These programs have shown an ability to remove labor-intensive functions from department responsibilities. By design, these programs have provided the Institute with efficient and cost-effective solutions to specific needs.

The most ambitious highlight of the past year was the two-phase installation of a new networked digital production environment. The integration of new digital devices with a new document management system was finalized in June 2000. This project, two years in research and one year in implementation, will significantly upgrade our ability to receive, produce, manipulate and deliver images using the latest technologies.

ACCOMPLISHMENTS

The Copy Technology Centers redesigned and updated our web site in the past year. Carefully re-examining the content, updating all services and pricing, and reformatting the site were the set goals of the undertaking. The new site is clearer and easier to navigate through. Pricing is included to allow Institute customers to estimate job costs for SAP purposes. The new site also is prepared for a number of Web submission initiatives that are planned, including electronic job and copyright submission.

The Copy Technology Centers participated in a coalition of MIT departments and service groups that examined paper recycling and other related issues. The Copy Technology Centers successfully tested and recommended recycled papers for Institute usage. As a result of this effort, our department also made the switch to using recycled paper in all of our operations. Our department purchases approximately 35 million sheets of white paper annually and the switch to recycled has provided a positive impression on any lingering concerns by Institute users. We will continue to participate in the coalition and will seek other ways to improve on environmentally related issues in our department.

The first year of the CopyTech Express Center in W20 has shown the successful concept of service specialization for a specific customer base, in this case, the MIT student population. The center is an evolving work in progress as hours of operation, service choices, and delivery are continually evaluated and refined. The success of the concept will be invaluable towards analysis of future site locations.

The major focus of the past year revolved around our plans for a new digital production environment. The early part of the year saw the selection and installation of new document management software. The new software replaced an older more restrictive system that was in place. New peripheral devices also were acquired resulting in a significant upgrade of a rapidly growing service. At the same time, a number of analog production copiers were replaced with new networked digital copiers. The first six months allowed for comprehensive testing and training of our staff. In June of this year, the final phase of the changeover took place. The installation of a new high capacity, networked digital copier along with additional smaller devices completed the hardware changeover. The new device represents state of the art technology and finalizes a new direction for the centers. Our department has been transformed from a network print service restricted to one center and two copiers, to a non-proprietary system that can choose from nine output devices in three locations. The completion of this project equips us with enhancements in the areas of quality, flexibility, and features. This new system has not only propelled us to a new level of service capability today, but also has prepared us for future innovations ahead.

FUTURE GOALS

With technologies constantly changing and improving, we will seek to stay on the very edge of advances in all of our service delivery areas. We will strive to enhance needed services all the while looking for ways to utilize breaking technologies. We will seek ways to operate cost effectively and maintain the commitment of quality to our customers. We will entertain carefully selected partnerships to enhance the delivery of services to the community and continually introduce improved methods, as they become available. Some specific goals are to :

- Develop partnership with MIT Libraries on a project that will enable students in libraries to have access to our database of scanned and available course readers;
- Explore partnerships with outside vendors in the areas of Web submission and copyright clearance;
- Define and manage the necessary blend of outsource partnerships for overflow production and finishing needs;
- Unveil to and educate the MIT community about the many changes and enhancements that the new digital production environment will provide;
- Further develop the electronic document strategy that our improved process has created, particularly in the area of mainframe electronic printing;
- Seek to expand on "Information Outposts" similar to our Express Center that will target locations and departments and match their needs with specialized services;
- Explore the potential of centers in the growing areas of MIT development, (Northwest area, Kendall Square, and West campus); and
- Examine the area of distance learning to see where our center can play a positive role in this future content delivery method.

More information on this department can be found on the World Wide Web at http://web.mit.edu/ctc/www/.

Steven M. Dimond

ENDICOTT HOUSE

The department achieved a $240,000 positive cash flow in fiscal year 2000 reflecting a 20 percent increase over the previous year. The continued development of business in all sectors along with new ventures generated a revenue increase of 18 percent. Continued efforts in facility renovation, targeted marketing, operations focus, and staff commitment were the primary contributors.

MIT bookings in fiscal 2000 equaled the previous year with revenues increasing by 17 percent as the events were larger in size and longer in duration. Bookings totaled 427 events of which 101 were MIT, a total booking increase of 12 percent. External business revenue contribution increases reflect our aggressive rate position.

Marketing efforts, spearheaded by Conference Center Consulting Group, played a key role in achieving the department's financial objectives. Strategies for developing new MIT bookings and additional external clients consisted of targeted mailings, local advertisement, and direct sales calls. Additionally, Endicott conducted a number of promotional events including the NEMICE event at the World Trade Center, MIT Meeting Planners Luncheon, Administrative Officers' presentation, Meeting Planners International Reception, corporate client luncheons and our third exhibit at the New England Flower Show.

Reinvestment in the property also has played a vital role in business growth. Over the past three years monies in excess of $600,000 have been invested in the property. Fiscal 2000 capital improvements included major renovations to the lecture hall, property irrigation system expansion, kitchen refrigeration upgrade, new furniture for meeting rooms, renovations of seven guestrooms, and function space remodeling. The department considers continued capital investment essential in maintaining self-sufficiency. In that effort a 10-year plan has been developed allocating between $150,000 and $200,000 annually.

We know that client satisfaction continues to be notably positive because of our business growth through a sustained high ratio of repetitive bookings. Each event is measured through client evaluations, sales debriefings, and on-site. Thus far responses reflect high marks for facilities and services but the responses also have identified areas requiring attention. Key areas of focus in Fiscal 2000 were service enhancements, staffing increases, professional development and training, along with capital planning. The dedication and commitment of Endicott House employees has proven an essential element in client satisfaction.

Through continued business growth the department anticipates revenues exceeding $3,000,000 in fiscal year 2001, thus yielding a positive cash flow for a fourth consecutive year. The department's strategic plan for fiscal 2001 is for growth in overnight conferences and new business services.

Michael Fitzgerald

FACILITIES

As steward of the Institute's physical plant, a prime concern of the department is the maintenance of its infrastructure. For several years, Facilities has maintained a facility audit of MIT's buildings and in February, published volume three of its renewal program activities report. A recent infrastructure renewal effort is the renovation of the undergraduate dormitory, Baker House. The department was pleased and honored to receive an award from the Cambridge Historical Commission for the restoration of this 50-year old building designed by Alvar Aalto.

Facilities was its own client when several of our offices were relocated due to the renovation of Building E18 office space for expansion of the Center for Learning and Memory. The administrative offices, including the director's area, moved to NE20 and the Design and Construction staff moved to Building 45 where its co-location with the newly defined Capital Projects Group will enable close coordination as the Institute enters a period of increased construction activity.

The department has several initiatives underway with other areas at the Institute including a Green Building Design Task Force with the Environmental Management Office. The general idea behind creating "green building design" is that lower energy use results in less pollution. This effort has huge significance to long-term sustainability both environmentally and financially.

Facilities is also working closely with the EMO in its recycling initiatives. Outreach to the community was provided at the Vendor Fair in October and during IAP at a joint session with EMO and the Housing Office.

With the restructuring of the Planning Office, Facilities assumed additional responsibilities for planning projects at all levels. One of these has led to a collaboration with the Publishing Services Bureau to provide the MIT community with up-to-date maps of the campus.

CAPITAL PROJECTS

During this past year, Facilities took a leadership role in the Institute's extensive building program. After an initial setback last summer, the department reconfigured the management of its Capital Projects Group and hired both a director of capital project development, Deborah Poodry, and a director of capital construction, Paul Curley. These partners are responsible for ensuring that the flow between project development and construction is a coordinated, disciplined, and smooth process.

The directors are currently hiring specialists in all aspects of large-scale capital projects. In addition, they are developing policy and procedures that establish guidelines for reporting on all aspects of a project including planning, design, schedule, and costs. Another aspect of tracking that the group is working on is to extend the link between their project cost control and budget control systems to SAP. Among other things, this will integrate with cost projections and track commitments with contractors. The Capital Projects group also is developing a five-year construction logistics plan in order to ensure smooth pedestrian and vehicular access to campus. This plan includes parking options on campus as well.

In order to keep the MIT community informed of the progress of the building program, the department has moved forward on several initiatives including hiring a manager of communications for capital projects. In addition, the director of Facilities made several presentations both on an off campus promoting the building program. The department also began a regular feature in *Tech Talk* and *The Tech* called "Campus Construction Updates," that features activities that will have an impact on the community. A web site including these updates as well as additional information is in development and will be online in the fall.

Among the projects in design and construction are:

- The Ray and Maria Stata Center for Computer, Information and Intelligence Sciences. A groundbreaking for this 350,000 sq. ft. facility was held in March 2000. The four-year construction of the center is currently underway.
- A 350 bed undergraduate dormitory being designed by architect, Steven Holl. This project has already received an award from *Progressive Architecture* magazine for design.
- A sports and fitness center scheduled to start construction in the fall of 2000.
- An expansion of the current Media Lab building currently in design development.
- An extensive three-year renovation of the Dreyfus Building is underway. This project received notoriety due to a student protest just prior to the construction of temporary faculty offices. These are now completed and occupied.

- A complete interior demolition and significant design development of NW30 was completed this year. Construction is scheduled to begin in late summer and will be finished in August 2001.

Additional information on the building program can be found at on the world wide web at http://web.mit.edu/president/communications/Building.pdf.

DESIGN AND CONSTRUCTION SERVICES (DCS)

A project managed by DCS, the Triad at MIT, a distance learning facility, won the American General Contractors Award as part of its Build Massachusetts Award Program. Several staff members accepted the award along with representatives from the Center for Advanced Educational Services. Since its completion two years ago, the facility has provided a fundamental technical and facilities nucleus that is enabling high-end distance learning to take root at MIT.

The departmental staff has continued to support the Committee for Review of Space Planning (CRSP) in defining a new approach to scoping space change projects. This process has enabled DCS to provide estimates early in the development of the project which, in turn, allows CRSP to consider complex space moves with minimal design effort.

In addition to the specific projects noted below, the department completed approximately 60 space changes, both large and small, as well as numerous smaller interior design projects that primarily involve furniture selection and installation, and a number of ADA accessibility upgrades across the campus.

Highlights of the year included:

- Three classrooms were completed on the first floor of Building 1, and the mechanical systems in the building were upgraded to provide a new standard for general purpose classrooms. These rooms feature data and power distribution permanently installed in new terrazzo flooring enabling future distribution of data to individual student stations. In addition, "touch screen" lighting and audio-visual controls have been introduced that provide "one stop control" for room lighting levels and audio visual functions. The rooms are designed to provide an acoustical environment that will lend itself to the potential installation of distance learning equipment with air handling systems that perform at an exceptionally quiet level.
- Construction continued for major renovations for the Department of Aeronautics and Astronomics in Building 33. The scope of the project includes complete renovation to the basement, first, and second floors and the construction of a new high-bay hangar. The project is scheduled for dedication in September 2000.
- Life safety and systems replacement were completed in Kresge Auditorium and the Chapel. Work in Kresge included ADA upgrades and the provision of modern performance spaces.
- Work to accommodate the Center for Learning and Memory in Buildings E17 and E18 was completed on the third floor and construction is underway on the second floor of E19 with a scheduled occupancy of summer 2000. This project will substantially accomplish a three-year campaign to upgrade laboratory space and infrastructures in E17 and E18.
- Construction nears completion in Buildings 2, 4, and 6 on Phases III and IV of the Chemistry Department's Master Plan for upgrading departmental spaces.
- Renovation of property at 304 Vassar Street is nearing completion with a late summer occupancy scheduled. This will yield approximately 50,000 square feet that will be occupied by Financial Systems Services (FSS) who are being relocated from Building N52 and by Information Systems that will yield additional space for academic use in E40.

FINANCE AND ACCOUNTING

Throughout the year, the Finance and Accounting area developed more efficient ways of working in the SAP system. These include improvements to customer access to billing for sales work, mechanisms for tracking labor allocation, and streamlined access to detailed financial records online. These developments were made possible by thorough questioning of records, ongoing system testing and adjustment, and strong communication with other administrative departments engaged in development and maintenance of SAP and related systems. Substantial strides to improve our electronic reporting and record maintenance systems were achieved and more work on this process will continue in the coming year.

An inclusive approach to establishing business unit budgets, begun with the fiscal 2000 budget cycle, was continued for the fiscal 2001 budget request and allocation processes. This unique methodology not only resulted in an increased level of fiscal awareness, but also created a much higher level of communication, cooperation, and efficiency among managers.

Finance and Accounting completed its first full year of a new initiative to improve existing campus infrastructure through a systematic program of capital renewal. In addition to accomplishing a variety of projects, Finance and Accounting spent this year refining a selection process to enable balanced yet speedy use of resources that complements existing programs and institutional objectives. For example, through the infrastructure fund, the Institute developed a five- to seven-year strategy to improve life safety systems in campus housing. Some infrastructure funds to study future projects will be set aside each year, thus improving the ability to effectively allocate resources.

Thanks to an infusion of new funds and the benefit of adding a systematic program of infrastructure renewal to the work underway in our department, the Major Repair Operation (MRO) was able to substantially increase its efforts to eliminate mid-sized repair needs on campus.

INFORMATION TECHNOLOGY GROUP

The I/T group implemented several of the recommendations in its strategic plan including the addition of new team members and a reorganization of the team's interface to the customer. The team will continue to implement the recommendations of that plan in fiscal year 2001.

A major upgrade of Maximo, an I/T system to track work within the Repair and Maintenance process, was begun. This upgrade will be completed in August 2000 and should provide significant additional functionality to its users.

Several enhanced PC and Macintosh programs were developed for use by Facilities employees. The development and maintenance of CAD facility drawings of campus-wide and internal building systems also continues.

The department prepared for and completed a smooth transition into the year 2000 for all of its I/T systems. The I/T group participated significantly in the department's move from Buildings E18/E19 to NE20 and 45 and continues to work with the central I/S group to address networking issues related to the move to NE20 (3 Cambridge Center).

The group continues to deploy desktop computers for use by all members of the organization and to provide significant I/T training.

OPERATIONAL UNITS

The operational units in Facilities, Buildings Services and Grounds, Mail Services and Repair and Maintenance, are benchmarking with a number of institutions within the Boston area and comparable institutions around the country. Operations will determine how its work processes and costs compare to others and look to develop more effective and efficient work practices.

The campus recycling program was enhanced to include mixed paper as well as white paper, aluminum, plastic and glass. Additional collection sites were established throughout the campus, both within buildings and outside to promote ease in recycling. In addition, a program to recycle CRTs, grounds waste, certain metals and food preparation waste was begun. The goal this year is to divert 30 percent of the Institute's waste stream to recycling.

Operations has a $650,000 initiative underway for campus beautification. Work to be performed includes improvements to address selected pavement, landscaping, and structural needs.

The process of producing labels for campus mailings was transferred from Human Resources to Mail Services. This transfer of responsibility results in faster turnaround time and therefore quicker and smoother delivery of on campus bulk mail. In addition, Mail Services is in the process of researching and purchasing a package tracking system that will enhance its ability to trace the route of parcels around campus once they are received at the MIT loading docks.

The operational areas corrected and/or solved all Y2K deficient mechanical systems and made a successful transition to the year 2000.

A new solid waste contract was developed, bid, and awarded to State Wide Carting. The former contractor for trash removal was BFI.

UTILITIES

Utilities completed several projects and started others to improve reliability and safety, increase production capacity, reduce plant emissions, and enhance resource conservation.

Among the energy initiatives is a new 2000 kW emergency generator to service the main group and Central Utilities Plant (CUP) that was installed and tested in time for the Y2K changeover. Another energy improvement is a major distribution expansion, the first phase of which was started in the railroad right-of-way behind the power plant. This

will ultimately expand steam, chilled water, electric, and telecom distribution in the railroad right-of-way and municipal and private utilities in Vassar Street for the full length of the campus. In addition, construction of chiller number six is well underway with foundations, building steel, and major equipment in place.

Life safety measures taken this year include the installation of the first portion of the West Campus Fire Protection Loop, including fire pump and standby generator in Johnson Athletics Center and underground piping to Baker House. The five-year Residential Life Fire Safety Project installed interim fire alarm equipment in East Campus a year ago, and this June commenced full construction of sprinklers, alarms, and emergency power and lighting in East Campus and Random Hall.

Among the energy initiatives implemented was the installation of a newly developed software by ABB in the gas turbine that will optimize environmental performance over the full range of ambient temperatures, humidity, and load. A water reclamation system was commissioned that captures process water in Building 13 for reuse in the CUP, saving 6.3 million gallons of water annually.

In addition, new metering in the CUP will facilitate $250,000 to $300,000 in potential savings annually in sewer charges by recording water that does not flow to the sewer.

Organizationally, Utilities added a full-time environmental manager to deal with all Facilities environmental compliance matters, and a full-time environmental engineer dedicated to the CUP. An aggressive program of staff training is underway and reporting, record keeping, and inspection systems are in development.

Another organizational change is the establishment of 24 hour/7 day per week supervisor coverage of CUP operations responsible for environmental compliance, reliability efficiency, and personnel supervision.

ADMINISTRATION

The department continues to promote diversity through its Learning and Performance section. In the fall the department hosted an exciting program on multiculturalism with Dr. Maura J. Cullen. In addition, Facilities has developed a new employee diversity training program based on the videotape "You Make the Difference" from the Griggs Productions Valuing Diversity Series. The goal is to help people become more sensitive to cultural, gender, and other differences and to promote better working relationships between all employees. This program is a requirement for all new employees in the Department of Facilities.

PERSONNEL CHANGES

Again this year, the department suffered the loss of a long-time employee, Neil Tomlinson. Neil started in Repair and Maintenance in April of 1977 as an electrician and was promoted to a supervisory position in 1989. He was known for his outstanding technical skills and for his dedication and commitment to Facilities and MIT. Neil will be greatly missed by all of us.

In the spring Robert Long, the Controller's Accounting Office (CAO) representative in Facilities, announced his retirement. Gregory Billington transferred from Financial Systems Services to become the new CAO representative in Facilities.

Two promotions of note occurred this year. Michael Sherman was promoted from analyst programmer III to manager of the application and desktop services section of the I/T Group. Jennifer Combs was promoted from environmental coordinator to environmental manager, underlining the department's dedication to government compliance and improving environmental initiatives on campus.

An open position in the department's human resources remains following the departure of Karen Nilsson, formerly the assistant director for HR. In December, she returned to the housing area, the department where she started at MIT, as associate director for operations in Residence Life and Student Life Programs. A search committee is currently in the process of reviewing that position.

AFFIRMATIVE ACTION

The department continues to work in conjunction with the special assistant to the vice president for equal opportunity and affirmative action programs to identify and attract minority candidates. The development of minorities and women within Facilities continues through training and education.

More information about the Facilities department can be found on the World Wide Web at http://web.mit.edu/facilities/.

Victoria V. Sirianni

OFFICE OF THE MANAGING DIRECTOR FOR ENVIRONMENTAL PROGRAMS AND RISK MANAGEMENT/SENIOR COUNSEL

The Environmental Programs Office (EPO) is a new office created in July 1999 by the Executive Vice President to take responsibility for overall environmental, health, and safety (EHS) management at the Institute. During its first year, EPO reorganized the offices at MIT with overlapping responsibility for EHS issues to create clearer accountability and responsibility for each of the many complex regulatory programs that govern MIT's work, and to provide more effective service to the MIT community. As of February 2000, three offices report to the EPO and form a cohesive EHS team. They are: the Environmental Medical Service, the Safety Office, and the newly created Environmental Management Office (which was broken out of the Safety Office). The new EHS team is focused on service to departments, labs, and centers and on leading the development of a more systems- and service-oriented approach to EHS management. Several of EPO's overarching philosophies include:

- a commitment to respect MIT's entrepreneurial culture, and within it to achieve an appropriate balance of local and central EHS roles and responsibilities,
- a commitment to serve the MIT community,
- a belief that with effective EHS management, positive initiatives achieve benefits beyond mere regulatory compliance and compliance is less burdensome,
- a belief that excellence in EHS management depends on integrating education, positive initiatives and compliance and on comprehensively approaching EHS issues rather than regarding them as separate concerns, and
- a commitment to the highest standards of professional performance.

To create clearer accountability and responsibility for all of the regulatory programs governing MIT's work as well as for positive EHS initiatives, the new EHS team identified over 200 unique programs, 187 specific federal, state and local regulations, and many positive EHS initiatives, and produced a matrix that assigns responsibility for each to a single position. A few programs that had not been fully accounted for in the past were identified in this process and addressed. The first two of several Human Resources-facilitated retreats were held to build an integrated organization.

With a clearer sense of accountability, the members of the EHS team are poised to support each other's efforts, cross-train in high priority programs to broaden professional competency, and generally improve client service and program management. The team initiated a cross-training program that will ultimately prepare staff across EHS departments to extend the scope of certain basic work, such as laboratory surveys, beyond that of their principal areas of expertise to a full range of the most important EHS issues.

The workers' compensation claim management function was transferred from the Safety Office to the Benefits Office of Human Resources to consolidate all injury-related and other benefits in one office.

Positive EHS Initiatives

An EHS Capital Project Design and Construction Group, comprised of experts in a variety of EHS disciplines, was established to provide EHS advice on capital projects that is expert, timely, and sensitive to overall project objectives. The EHS Group is led by a senior EHS staff member, who is integrated in each Facilities department capital project team to more fully appreciate project objectives and be better able to exercise good judgment concerning the relative importance of EHS issues and other project objectives. A method to facilitate the resolution of difficult issues also was established.

The EPO convened an Environmental Programs Task Force, comprised of representatives of Facilities, Custodial Services, Campus Activities Complex, Dining Services, the Executive Vice President's Office, Student and Residential Life, Conference Services, the Copy Center, Procurement, Publishing Services Bureau, the Planning Office, and students (many of whom are members of SAVE), to undertake positive campus environmental initiatives. Working together, the Task Force achieved results that would have been impossible if departments had worked in isolation. The Task Force's major accomplishments are:

In January 2000, recycling receptacles for mixed paper and for commingled goods (plastics numbered 1 through 7, aluminum, and glass) were installed next to most indoor common area and outdoor trash receptacles. Desk-side recycling was expanded from white paper only to mixed paper (including cardboard, newspaper and magazines, and white and colored paper). A new recycling contractor who is capable of and committed to keeping accurate records of recycling rates was procured and will be serving the entire campus and residential life's recycling needs. Recycling, as a percent of total waste generated, increased from approximately 5% to 17% in a five-month period. There is a 30% goal by January 2001. Work began and is underway to promote recycling of appropriate construction debris by the Institute's construction contractors. The EPO funded the purchase of a recycling truck for the Facilities

department, which will assist the custodial staff in collecting recycled goods and allow us to make better use of campus facilities.

With support from the Task Force and from many departments across the Institute, the Procurement department and the Copy Technology Centers led a conversion to the use of high recycled content (30 to 50%) process chlorine free paper by most high volume paper users. Office Depot was asked to feature recycled products in its on-line service. Recycled goods were featured at several vendor fairs. Conversion to the use of other more environmentally responsible products, such as reusable toner cartridges, is underway.

With support from the Task Force, Dining Services initiated a food composting project at Walker Memorial, composting approximately four tons of food waste monthly. The pilot was successful and the food composting project is ready for wider implementation in large dining venues.

The Managing Director for Environmental Programs and the Director of Facilities cosponsored, with participation by Professors Leon Glicksman and Leslie Norford, the creation of a Green Building Task Force. The Task Force is comprised of Facilities, Capital Projects, Utilities, and EHS staff, faculty, and a graduate student funded by EPO and Facilities. It began work to develop performance-based sustainable design guidelines for consideration, along with other project objectives, by designers on MIT's capital projects. Long-term objectives will be established and the guidelines will be tied to achieving these objectives.

EHS Management System

The Discovery Process commenced and made significant progress in defining the possible automated components of a comprehensive Environmental, Health, and Safety Management System for MIT that will integrate positive initiatives, education, and compliance. As a result of the federal Environmental Protection Agency's May 1998 campus inspection, MIT will implement an environmental management system. Work began to define a process for involving faculty, researchers, staff and students in the management system design process to ensure that the system works well for the community it is intended to serve.

A new program was mandated by Congress to address potential bioterrorism actions. It requires the identification and strict control of certain biological agents and toxins used at the Institute. Lincoln Laboratory has been successfully registered under this new regulation. Efforts are underway to register the main campus. These agents will be controlled in essentially the same way as radioactive materials with strict oversight by the Biosafety Office. Other EHS team members took a training course to increase their capacity to address a bioterrorism emergency.

Program Improvements

The handling and disposal of sharps, animal/pathology, and hazardous chemical wastes were improved to ensure regulatory compliance and decrease costs with a minimum impact on the research community.

The Institute system and facilities that store hazardous waste were improved by implementing a data tracking system. The central hazardous waste storage area in Building 12A was improved with a new air handling system and a floor sealing containment system. Various emergency and preparatory plans were upgraded and updated as well. The Institute now has a significant supply inventory that can deal with reasonably expected spills and other hazardous materials incidents.

The delivery and content of EHS training was enhanced by two new web based training courses with a third in the beta-testing stage. Over 200 people have successfully completed the Chemical Hygiene hypercourse. The Hazard Communication and Hazardous Waste hypercourses are now being implemented. These materials will provide good models for the development of the EHS Management System's educational component.

In collaboration with Facilities, the EHS team supervised the initiation of a procurement process to more expertly contract with qualified and cost effective environmental consultants for a wide range of services. A standard form of environmental consulting contract was developed as well. Proposals have been received and are being evaluated.

The EHS team hired a 13-year veteran of Camp Dresser McKee, who is a professional engineer and a Licensed Site Professional under the Massachusetts Superfund Act regulations. This highly qualified professional supervised the response to releases and discoveries of regulated materials on campus, an increasing phenomenon as MIT embarks on its expanded capital program.

Regulatory Interactions

Progress was made in discussions with the federal Environmental Protection Agency (EPA) regarding its 1998 multimedia inspection of approximately 25 percent of MIT's labs and centers as well as certain facilities. At EPA's request, the Director of the Office of Environmental Management spoke about the inspection at two EPA

conferences on EPA's University Initiative. EPA conducted a Toxic Substances Control Act inspection in the past year and found no violations. The EHS team worked with the Office of Community and Government Relations in support of EPA's Clean Charles 2005 Initiative.

$25,000 settlement was reached with the Massachusetts Department of Environmental Protection (DEP) and Attorney General's Office regarding an enforcement action against MIT. The action concerned inaccurate data reporting from the Central Utility Plant caused by faulty software. There was no damage to the environment.

Two formal complaints were made to the Occupational Safety and Health Administration (OSHA), one from E19 concerning possible exposure to asbestos and odors and blocked egress, and the other concerning possibly improper storage of gas cylinders. Both were handled by letter to OSHA's satisfaction and as a result no inspection was conducted and no violations were issued.

The Massachusetts Department of Public Health performed two radiation inspections (totaling five days on site), which resulted in one minor violation each time and no monetary penalty.

The Nuclear Regulatory Commission inspected the Nuclear Reactor on three occasions, with each inspection lasting five days. There were no notices of violations and no other adverse findings.

Biennial training for the Cambridge Fire Department Hazardous Materials Response team was conducted for radiation safety, nuclear reactor safety, chemical hygiene, air sampling and biological hazards. Members of the EHS team worked with the Fire Department on emergency planning procedures.

Several members of the EHS team participated as members of the Cambridge Local Emergency Planning Committee.

Testimony was provided to OSHA on the proposed ergonomics standard.

Testimony was provided to the Department of Energy (DOE) on the proposed Beryllium standard.

Professional Activities
Members of the EPO played prominent roles in several national organizations. Over 20 presentations were made at the national level. At least 10 articles/books were published. This year the Radiation Protection Office hosted the 17th biennial North American Campus Radiation Safety Officer Conference with 160 professionals from the US and Canada in attendance. The Managing Director was appointed to an Advisory Committee of the Commissioner of the Massachusetts DEP.

OFFICE OF THE SENIOR COUNSEL

The new position and Office of the Senior Counsel, reporting to the Executive Vice President, was created in the last year. The Senior Counsel is also the Managing Director for Environmental Programs and Risk Management. This position is responsible for all legal services for departments reporting to the Executive Vice President. The Senior Counsel is also responsible for developing and administering the Institute's general legal budget for outside legal services, for generally evaluating the cost-effectiveness and quality of legal services to the Institute, for evolving a more systematic and business-like approach to legal services, and for otherwise providing legal services to the Institute as needed. The following lists the Office of the Senior Counsel's principal accomplishments in the past year.

A standard retainer letter agreement was developed and executed by many of the firms that perform substantial legal services for MIT, including MIT's primary outside counsel, Palmer and Dodge. The retainer letter establishes discounts for many types of services (many at the 10 to 15 percent level, and some at higher discounts), allowable and prohibited reimbursements, accounting and reporting controls to track costs, and processes for establishing budgets and approving the qualifications and numbers of lawyers working on matters. With these retainer letter agreements, MIT saved $100 to $150 per hour on services performed by two firms, compared with the rates MIT has been paying for many firms, and saved 10 to 15 percent on most other services performed by firms under retainer letter. One firm provided a 10 percent discount for billings over $1 million, and agreed to consider revisiting the issue. Legal bills were for the first time distributed to the primary clients across the Institute for review before payment, to ensure that clients received the services being billed and were satisfied with the quality and value of such services.

With assistance from the Controller's Office and the Data Warehouse, a legal services general ledger account was created in SAP to ensure that legal costs could be tracked for the first time. A reporting format on the Data

Warehouse was also created to provide for legal cost reporting sorted in a variety of ways. Much of the cost tracking work for the past year had to be done by hand until these systems were complete. However, the Office of the Senior Counsel will be able to track and report on legal expenditures for the coming year in SAP.

The Senior Counsel led a team of administrators that supported Chancellor Lawrence Bacow and Professor John Vander Sande in the negotiation and documentation of the Cambridge-MIT Institute, which will bring $80 million from the UK government to MIT for joint research, professional practice programs, and undergraduate student exchanges with the University of Cambridge. These complex negotiations involved representatives of the UK government and Cambridge University. Highly effective support from outside counsel, focused on protecting MIT's corporate interests, was obtained for a very reasonable budgeted cost.
The Senior Counsel provided legal services and oversight in the development of standard forms of design, construction, and environmental and other consulting contracts for MIT. The Senior Counsel also provided legal services and oversight of the permitting process for major capital projects. She worked with the Managing Director of Real Estate and the Director of Capital Project Development on issues relating to regulation of MIT's campus and projects by the Historical Commissions of Massachusetts and Cambridge, and on proposed revisions to the Cambridge zoning ordinance. She also is overseeing the litigation challenging the IPOP special permit that was granted for the Student Residence project.

The Senior Counsel represented MIT before federal and state environmental regulatory agencies.

The Senior Counsel provided guidance and oversight in connection with major litigation, including several cases in the Technology Licensing Office and Insurance Office. She developed a form of Artist's Contract for the List Gallery that can be used in connection with acquisitions, including those relating to capital projects. The Counsel and Director of Insurance provided legal services in connection with a cafeteria contract, litigation and other matters. The Senior Counsel developed oral history gift and consent agreements for the Archives and provided other advice to the Archives. She counseled the Dean's Office, the Registrar's Office, the committee that addressed the Census, the Committee on the Use of Humans as Experimental Subjects, Information Systems, and various other Institute offices. She also has increased the coordination of work among other Institute attorneys to best serve the overall interests of MIT.

RISK MANAGEMENT AND INSURANCE

The new Managing Director for Environmental Programs and Risk Management is also responsible for enterprise-wide risk management at MIT. The former Office of the Director of Legal Services and Insurance began reporting to the Managing Director this year. That Office's legal functions were incorporated into the new Office of the Senior Counsel. The remaining Office of Insurance focused on providing appropriate insurance coverages for risks at the Institute. The Business Continuity Management team also began reporting to the Managing Director. The following principal initiatives were undertaken in risk management and insurance.

The Managing Director for Environmental Programs and Risk Management and the EHS team led two major initiatives relating to emergency response systems at MIT.

First, the EHS team led two reviews of the Institute's existing fire, chemical release, explosion, and confined space Emergency Response Program, one by a task force comprised of the EHS team, Facilities, and Campus Police and the second by an outside consultant. Recommendations are being developed to improve the program, primarily using existing resources. Interim program improvements included an increase in available EHS expertise in off-hours and expanded training for emergency responders.

With assistance from Human Resources, the Managing Director for Environmental Programs and Risk Management and the Director of Enterprise Services led a multiple-department initiative to map and record existing emergency response protocols of the Campus Police, EHS team, Facilities, and Residential Life and Student Life Programs office and to encourage a more systems-oriented approach to emergency response. Connections between various departments' protocols were drawn where appropriate, and the roles and responsibilities of each department in different categories of emergencies began to be defined. Work is continuing with the goal of producing a comprehensive written emergency response guide that can be used by emergency responders and other members of the MIT community. An expanded group that includes the task force as well as the News Office, Registrar's Office, Dean's Office, MIT Medical, Business Continuity Management team, Athletic Department, Government and Community Relations, and Conference Services is working on improving front-line emergency response communications.

Members of the EHS team worked on the Y2K team to address MIT's needs. The Managing Director monitored progress for the Executive Vice President.

The Managing Director met with a number of members of the MIT community and developed an agenda of the most compelling risk management issues at the Institute, in addition to the ones relating to EHS issues. Among those consulted were the Institute Auditor (out-going and incoming), the Vice President and Dean of Research, the Institute Archivist, an Ombudsperson, Dean's Office and Residential Life representatives, Director and staff of Facilities, various inside and outside lawyers, students and faculty. The Senior Counsel/Managing Director began working with the MIT community on a number of the agenda items, including various student life issues, capital projects contracting, and interim sanctions. In some cases working with the Institute Auditor and others at MIT, the Managing Director is prepared to proceed with a number of the agenda items in the coming year.

The Insurance Office, working closely with the Senior Counsel and Capital Projects Office, initiated a new program to cover construction contractors' insurance for major capital projects through an owner's controlled insurance program (OCIP). Under the OCIP, MIT has purchased the workers' compensation, general liability, and excess liability coverage for contractors working on MIT's major capital projects. After careful analysis of the economic, administrative, and project management merits of the program, coupled with the significant volume of construction projected over the next five years, MIT committed to the OCIP under a guaranteed cost structure. The program includes a number of risk management approaches, including a drug testing program for construction workers and the requirement that contractors prepare detailed safety plans. If modeling to forecast savings (to include expected losses, projected payroll) is proven reasonably accurate, the Institute should realize savings of approximately $2 million. Costs and savings will be tracked throughout the life of the program to evaluate its effectiveness.

The first phase of a comprehensive review and analysis of MIT's property and casualty insurance and risk management program was completed by Aon Risk Services, Inc. of Massachusetts with substantial support from the Office of Insurance. Initial findings, including recommendations for higher levels of coverage for catastrophes and higher retentions with lower premiums for basic liability coverages, were presented at Barton Insurance Ltd.'s annual Board of Directors' meeting. Follow-up work is underway to benchmark recommended coverages and approaches against those of peer institutions, and to examine the potential cost savings, and overall costs and benefits, of alternative methods of structuring MIT's insurance program.

Premiums for most lines of insurance remained fairly level for fiscal year 2000. Due to the high frequency of claims against the Educators Legal Liability Policies (ELL), particularly employment-related claims, increasing defense costs, and consistently high damage awards across the nation, our ELL insurer raised minimum retention levels from $100,000 to $150,000 to $250,000 (depending on whether insurer-approved counsel is retained). Market conditions for other liability lines have allowed MIT to realize 7 to 20% savings on premiums in excess, umbrella, publisher's liability, and nuclear liability coverages.

Under ongoing property loss claims, MIT recovered an additional $300,000 from its property insurer for fiscal year 1997 cogeneration losses, in connection with disputed costs. In July 1999, the same insurer reimbursed MIT $108,000, for damages resulting from the heavy rainstorm in June 1998.

Several liability claims were favorably resolved during the year, including several employment-related claims, a fraternity-related claim, and a claim arising from a contractor dispute at Lincoln Laboratory. However, a number of matters remain in active litigation. They include several employment-related claims, several claims arising out of alleged alcohol-related incidents at fraternities, as well as the remaining procedural claims in a case in which a jury in November 1999 found MIT to be not liable for claims related to research conducted at our nuclear reactor in the 1960s.

Jamie Lewis Keith

PARKING AND TRANSPORTATION OFFICE

The Parking and Transportation Office (PTO) is responsible for the operations of the following:

- Parking permit allocation, issuance, and management
- Parking facility management—4,814 Spaces
- Parking violation issuance and management
- Subsidized MBTA Pass program
- Saferide Shuttle program
- Tech Shuttle

The director of Parking and Transportation provides day-to-day management of the department, and the rest of the staff are employed by Standard Parking. There are presently 30 full-time employees working under the auspices of Parking and Transportation.

The PTO is committed to providing a high level of customer service to those within the community as well to those from outside of MIT. PTO also provides effective planning to ensure the maximum usage of all parking facilities. This also includes consideration for facility placement, construction, and repairs.

PARKING PERMIT ALLOCATION, ISSUANCE, AND MANAGEMENT

MIT is required by the Federal Clean Air Act of 1973 to provide parking to no more than 36 percent of the MIT commuting population. Due to this restriction, parking permits are not available to all who would like to have one. The total annual number of available parking permits is determined via an allocation system by the Parking Office each July. These allocations are distributed to each department for assignment. The local assignment of allocations provides a more flexible distribution system that accounts for special circumstances within that department.

There are currently 5,536 members of the MIT community with parking privileges, accounting for 6,985 stickers. There are 15 different parking permit types; 12 for employees and 3 for students. Parking allocations are done annually and take effect around September 15 of each year. All parking permits are valid from September 1st through September 15th of the following year. This means that the Parking Office issues nearly 7,000 parking stickers between August 15th and September 15th annually.

PARKING FACILITY MANAGEMENT

MIT has four parking garages and 23 open parking lots. The parking garages are the Albany Garage, the West Garage, the East Garage, and the Hayward Garage. All of the facilities have maintenance needs, including capital repair projects. The PTO coordinates these projects while maintaining a level of service needed to serve the Institute.

The allocation process distributes parking permits throughout all of our parking spaces on campus. For this reason, the intensity of use of each location is predetermined. In most parking locations, each space is over-allocated by a factor of .1 to .5 depending on intensity of use. The PTO also must accommodate the Institute's visitors and the occasional parking users using the same spaces. Due to the uncertainty of how many visitors and occasional users will come in each day, the lots will fill up from time to time. Overall, this approach has provided the maximum use of space possible, with minimal inconvenience to our customers.

All of the parking facilities east of Massachusetts Avenue are at or near 100 percent occupancy during the school year. Most of the facilities to the west of Massachusetts Avenue operate well below capacity. This is largely due to the concentration of office locations in Main and East campus, but the supply of parking spaces to the western parts of campus. Parking lots like the Pacific Annex and the West Lot are holding places for future buildings. As buildings are erected in the western part of campus, these unused spaces will then be needed. Should MIT remove parking spaces without relocation elsewhere, the City of Cambridge could consider them permanently removed from our inventory. MIT will need to replace all parking spaces lost due to building projects or risk a loss in the level of service enjoyed today.

PARKING VIOLATION ISSUANCE AND MANAGEMENT

The Campus Police as well as the PTO issue MIT motor vehicle violations on campus. There are 13 different motor vehicle violations.

Table 1. Violations Issued In 12 Month Period

Violation Type	12 Mos. Issued	Fee
Parking Over Time Limit for Zone	306	$20
No Permit for this Area	7,478	$20
Parking in Area Not Marked for Parking	610	$20
Blocking Roadway, Driveway, Entrance or Crosswalk	94	$30
Parking in a No Parking Zone	811	$30
Parking or Driving on Sidewalk or Lawn	84	$30
Blocking Fire Lane or Hydrant	106	$40
Parking In Reserved Space	234	$40
Blocking Loading Zone or Dumpster	151	$50
Parking in Area Reserved for Handicapped	70	$50
Blocking Wheelchair Ramp	33	$50
Driving to Endanger	5	$50
Speeding	7	$50

There were 10,206 violations issued during the 12 months ended May 1, 2000.

SUBSIDIZED MBTA PASS PROGRAM

MIT's subsidized MBTA Pass Program provides $10 off of a monthly pass for students and employees. Employees must be eligible for payroll deduction and must not have a full MIT parking permit to participate. Students must be registered and cannot have an MIT parking permit. The amount MIT subsidizes each Tpass will increase next fiscal year. The new subsidy amount will effectively be 50 percent of the face value. This in turn should increase participation in the program as well.

In April 2000, there were 3,407 participants in the Tpass program. Of these, 1,735 were students and 1,672 were employees.

SAFERIDE SHUTTLE PROGRAM

The Saferide shuttle program operates from 6 pm to 3 am, Sunday through Wednesday and from 6 pm to 4 am, Thursday through Saturday. There are currently five passenger vans, three of which are 12 passenger, and the other two are HP accessible and can seat 10 passengers.

The vans operate on fixed routes each day of the year. There are two routes that serve Boston (East and West) and two routes that serve Cambridge (East and West). The last van is put into service during heavy demand or when one of the other vans is out for service.

All members of the MIT community are eligible to use the Saferide service. However, the vast majority of passengers are students going to and from their living quarters. The service times and routes are determined by the location of student residence houses.

Use of Saferide has increased significantly in the past few years. There has been considerable discussion to upgrade the service to accommodate the increased demand.

TECH SHUTTLE

The Tech Shuttle was designed to provide daytime transportation to all members of the MIT community. The route operates in a loop from Kendall Square via the MBTA stop to Audrey Street by the Tang and Westgate residences. The shuttle runs from 7 am to 7 pm Monday through Friday.

The shuttle bus is owned and operated by Paul Revere, and coordinated by the Charles River Transportation Management Association (CRTMA). The PTO works with the CRTMA to determine the schedule, routes, and headway's for the shuttle. MIT provides 100 percent of the cost of this shuttle that serves 200,000 passengers per year.

More information about this department can be found on the World Wide Web at http://web.mit.edu/parking/www/.

John M. McDonald

PLANNING OFFICE

I begin this report with the very painful news that in March of this year, Executive Vice President John Curry informed me of his decision to dissolve the Planning Office and to disperse its staff to other organizations. The Planning Office was created during the administrations of Chairman James R. Killian and President Julius Stratton in 1958 in order to provide and maintain a long-range plan for MIT. It has been my privilege to serve five presidents as the leader of the Planning Office since my appointment in 1960.

I believe the office has made a real difference for this community and deeply regret the dissolution of an organization devoted to providing creative, thoughtful and coherent plans and policy initiatives to MIT in a number of spheres, internal and external. It is worth noting a few of its achievements. During this time the campus plan has guided the growth of MIT from four million square feet to more than nine million square feet. Large areas of the campus that were parking lots and archaic industrial buildings are now occupied by handsome buildings and green spaces. The Planning Office played a central role in the defeat of a proposed eight lane, double-decked inner belt highway that would have passed through the campus.

Among its many achievements, the Planning Office played a key role in the redevelopment of the former industrial district that is now Technology Square and Cambridge Center. It conceived of and saw to fruition the new location of the Kendall/MIT MBTA station and the MIT timeline that decorates its walls. The Planning Office developed one of the first university computerized facilities management systems and we developed a still state-of-the-art tactual map for the blind. The reach of the office's accomplishments is international in scope and is a source of pride for all of us.

In spite of this unsettling event, I want to record that the talented and dedicated members of the staff produced an impressive record of accomplishments this year.

The Campus Development and Landscape Plan being prepared by Laurie Olin and Associates, landscape architects, occupied the energies of Michael Owu and Jennifer Marshall, who provided primary planning support and analysis for this effort.

The Institutional Research Group led by Lydia Snover and her associates Bea Frain and Wojciech Beltkiewicz continues to produce a prodigious variety of reliable and valuable planning information and policy analysis that serve the President's Office, faculty committees, visiting committees, academic departments, Alumni Association, and students. This planning group responded to hundreds of surveys sent to MIT from public agencies and a variety of outside media organizations. The Institutional Research Group is MIT's key link to organizations such as the Association of American Universities (AAU) data exchange, which provides MIT with valuable comparative data. It made it possible for the Planning Office to continue to provide the President and the MIT Washington office with accurate and reliable MIT data and comparative analysis used in congressional briefings.

Among the group's achievements this year was the administration of a new alumni survey jointly with the Alumni Association and Dean for Student Affairs. The staff also conducted the surveys necessary to support Associate Provost Phil Clay's work on the proposed expansion of childcare services, and it provided the data and research support for the Faculty-Administration committee on retired faculty. The group was asked to create a database on faculty, instructional and research staff, and has begun that effort. It took on the responsibility for maintaining data on earned doctorate degrees and has established a Web site that provides public access to institutional data. President Vest and former President Gray have both written letters in praise of Ms. Snover's efforts on MIT's behalf.

Planning for new academic facilities continued, with efforts focused on changes in the Stata Center project, which will now include a major parking facility. We explored the site options for the new Neuroscience program, the expansion of the Media Laboratory, a siting study for the nanovation technology project, and development options for the Schools of Management and Humanities and Social Sciences.

Transportation and parking continue to be key issues for MIT's future. Mr. Owu and Ms. Snover, working with the Strategic Parking Committee, developed alternative means of meeting MIT's parking needs. Major efforts were invested in seeking ways to expand the bus shuttle services. The Planning Office received an award on behalf of MIT from the state's Caravan program for its efforts to encourage ride sharing. Support for the Committee on Transportation and Parking was provided by Ms. Snover, Ms. Frain, and Mr. Owu. The key issues this year dealt with parking service levels, parking costs, and alternative transportation modes.

The Planning Office continued its efforts to work with the City of Cambridge and the Metropolitan District Commission to resolve the pedestrian safety problems on Memorial Drive and Massachusetts Avenue. The Institute, in view of the lack of public funds, committed itself to installing traffic signals at Endicott and Wadsworth streets to improve safety for pedestrians crossing Memorial Drive. The Urban Ring project, which will have a major impact on MIT, continued to move forward. I serve as a member of the Working Committee appointed by the MBTA on this project, and will continue to monitor and report on its progress.

Housing planning and enrollment management policy were key responsibilities of Robert Kaynor. The sensitive relationship between enrollment policy and housing was dramatized this year, as planning for the required residence of freshmen on campus draws closer. Working with the Dean's enrollment management group, Mr. Kaynor developed a number of scenarios, which ultimately produced a recommendation to the Academic Council.

New strategies for developing and paying for graduate housing were developed by Mr. Kaynor for the proposed graduate residence at 224 Albany Street. This plan was approved by the Building Committee and is now moving forward.

The undergraduate residence has moved through the community review and public approval process but is now delayed by litigation brought by a neighboring property owner.

This year we lost the services of Eric Novak whose expertise in housing development was invaluable to the Institute's housing programs. He is missed.

Mr. Owu provided planning staff support and studies for the Office of the Dean for Student Affairs and Undergraduate Education. This included studies for the Admissions Office, Registrar's Office, Athletic Department, and service on the Athletic Board.

The growing regulatory environment in Cambridge required substantial effort from the Planning office staff this year. Mr. Owu provided the zoning analysis for all new capital projects. He coordinated the presentations to the Cambridge Planning Board for special permits and prepared (for the Cambridge Historic Commission) the necessary documentation required for the demolition of buildings in the way of new capital projects. In addition, he provided the ongoing analysis of proposals coming forward from the City-wide rezoning efforts and maintained close working relations with the Cambridge Public Works Department. At Mr. Curry's request, I ended my service as representative for MIT on the City-Wide Growth Management Committee.

The staff of the Planning Office was active in public and professional service this year: Mr. Owu served on the Cambridge Pedestrian Committee and on the Professional Development Committee of the Society of College and University Planning (SCUP). Ms. Snover represented MIT at a national workshop on graduate student support at the National Science Foundation and served as a member of the special task force on indicators that supported the AAU Membership Committee.

Mr. Kaynor served on program development committees of the National Association of College and University Business Officers and of SCUP. He also presented a paper on inter-institutional data sharing at the European Association of Institutional Research in Lund, Sweden. Concurrently, he completed a research paper on the impact of a new university space and facilities management law that now governs Swedish universities.

Recognition for professional accomplishments and contributions has often been won by members of the Planning Office. This year I received the Society for College and University Planning Distinguished Service Award.

I regret that this will be my last report to the President as the Director of the MIT Planning Office. In this report, however, I would like to salute the many fine people who have served in this office, both professional staff and students. Many have gone on to make exciting contributions to the field of university planning. Their creativity and good works have given luster to this institution. Many of the pioneering planning techniques and methods developed here are now in use at other institutions both here and abroad.

I also would like to thank the 10 generations of students, the hundreds of faculty members, and the many mentors and colleagues in the administration that I was privileged to serve and to work with. A special note of thanks to Phillip Stoddard, retired Vice President, for the opportunity to make a contribution to this very special place.

In closing this report, I would like to take note of the "Eulogy for the Planning Office" written by an alumnus, Jeremy Scher, and published in *The Tech*, April 14, 2000. It describes our hard work and cooperation, our passion for the idea that MIT is a family where we learn from each other and care about building and sustaining an environment where "living communities encourage spontaneity and fun—in short, an Institute ready to flourish in the coming century."

One can have no greater satisfaction at this place than having a student speak such words. It makes it all worth it.

O. R. Simha

TREASURER

In fiscal 2000, revenues and funds of $1,328.3 million were used for operations. Total operating expenses were $1,290.0 million. The results of operations were $38.3 million in fiscal 2000 in comparison to $23.5 million in the prior year.

In addition to the management of the investment program, the Office of the Treasurer provided assistance to the Institute's overall financial plan in conjunction with the Office of the Executive Vice President.

Other activities of the Office of the Treasurer supported Institute real estate planning, community relations and the Office of Resource Development.

Allan Bufferd

VICE PRESIDENT AND SECRETARY OF THE CORPORATION

The Vice President and Secretary of the Corporation is responsible for relations and communications with internal and external constituencies and is the key interface between MIT's administration and trustees (the members of the MIT Corporation). The offices reporting to the Vice President and Secretary of the Corporation—working independently but collaboratively—comprise Public Relations Services: the Communications Office; Conference Services, Events, and Information Center; the News Office; the Publishing Services Bureau; and Web Communications Services. In addition, the Office of the Secretary of the Corporation supports the work of the Corporation and its committees.

PUBLIC RELATIONS SERVICES

The offices within Public Relations Services (PRS) support the mission of the Institute by enhancing public understanding of MIT and of higher education and research more generally and by supporting the community life of the Institute through communications and special events. The academic year 1999–2000 was eventful for the Institute and for Public Relations Services on all these fronts.

Staff in PRS continued developing and implementing strategies to strengthen and make more consistent communications for internal and external audiences. Priorities include graphics, branding, and institutional identity; enhancing understanding of institutional priorities and initiatives within the MIT community; improving the experience of visitors to campus, including prospective students; enhancing public support for higher education and research; and providing for the Institute-wide coordination of major activities and special events. To provide ongoing opportunities for the exchange of ideas and information on such issues, the Vice President and Secretary of the Corporation convenes monthly meetings of the Communications Operating Group and the Information Group.

In recognition of the increasing importance of the World Wide Web to internal and external communications, Web Communications Services (WCS, formerly Campus-Wide Information Systems) began to report jointly to PRS as well as to Information Systems. This new relationship formalizes the already close collaborations between WCS and other PRS offices, particularly its neighbors in E28, the Communications Office and Publishing Services Bureau (PSB).

This year, the Institute sponsored two special events that brought faculty, students, and staff together in community celebration—the Millennium Ball at the close of Independent Activities Period and the third running of the Johnson Games in April. Staff from across PRS were central to the planning and implementation of both events. This year saw changes in schedule and logistics intended to keep Commencement events running smoothly despite growing numbers of students and guests.

As the year came to an end, Bruce M. Bernstein, who has directed PSB from its inception, announced that he would leave the Institute to pursue an exciting opportunity in the private sector. His energy and vision have contributed greatly to the successful establishment of PSB, and he will be much missed by friends and colleagues across campus. He will be succeeded as Director by PSB colleague Monica Lee.

Kathryn A. Willmore

COMMUNICATIONS OFFICE

The Communications Office publishes and distributes official reference information on MIT's educational, research, and administrative policies and programs that is current, accurate, and accessible, in both print and electronic versions. In collaboration with the Publishing Services Bureau (PSB) and Web Communications Services (WCS), the Office advises and assists the MIT community with communications planning and policies.

Among the key accomplishments for the year were the following:

- Publication of the 1999 edition of the faculty picture book, the first issue since 1992. The use of digital photos obtained from the MIT Card Office changed the production cycle dramatically. Office staff created a new database to hold both faculty information and images, and, by doing the work in house, saved the Institute more than $18,000. Using the template created by the Publishing Services Bureau for MIT's annual reports aligned the publication visually with other key Institute reference information. The publication addressed a community need for up-to-date information on faculty. Equally important, the production process brought to light systemic problems that must be addressed in order to collect accurate faculty information in a timely way in the future.

- Participation in the Curricular Information System (CIS) project sponsored by the Registrar, which has driven much of the work on the course catalogue. The project's goals include the creation of a single, integrated system for generating, revising, and publishing information on departmental degree programs, requirements, and subject listings. To support this work, the Office has refined content guidelines for departmental descriptions; ensured that the list of centers, labs, and programs reflects MIT's organization chart; and worked with a GSO team to develop an information map for graduate education.
- Working closely with the Office of Academic Services, publication of the entire contents of MIT's course catalogue on the web. A decrease in sales of the print catalogue reflects the increased popularity of online information.
- Continued development (with the Institute Archives) of a content template for the *Reports to the President.* The goal is to capture MIT's history more completely while simplifying the creation of reports.

In addition, staff member Lori Weldon served on the Enhanced Voice Directory System team to install NameConnector, a voice activated, telephone auto attendant that serves as a backup to the MIT telephone operators during regular business hours and becomes the primary response outside of regular business hours.

This year, Director Barrie Gleason devoted one-quarter of her time to planning communications with the Graduate Students Office (GSO), and next year will be "on loan" to the Graduate Students Office for three-quarters of her time. The goal of this work is to develop a set of consistent, integrated messages that present a coherent view of graduate education at the Institute. The project involves working with departments throughout the Institute, and as such, provides opportunities to develop collaborative leadership models and a greater sense of common purpose among the various graduate programs. This work will also assist PSB and WCS in the design of a suite of services for future communications planning efforts within the MIT community.

Future Plans

Future plans for the Office include the following:

- Incremental changes in products and processes for the annual reference publications.
- Publication of a prototype of MIT's online organization charts.
- Continued work with PSB and WCS to more fully integrate design and production services for print and electronic communications.

In August 1999, the Communications Office welcomed Jennifer Fletcher to the team as Publications Manager. She brings a wealth of publishing experience from her previous work in the Office of the Registrar at Harvard University.

More information about the Communications Office can be found at http://web.mit.edu/communications/.

Barrie Gleason

CONFERENCE SERVICES, EVENTS AND INFORMATION CENTER

The mission of the Center is to meet the information needs of the MIT community, visitors to the campus, and the public; to promote a sense of community within MIT; and to support conferences and events which enhance MIT's role in the broader academic community.

Events And Information Center

The Center continued to serve as an information and welcome point for visitors, as well as a central information source for members of the MIT community. Staff in the Center distributed over 31,000 pamphlets, brochures, maps, guides and catalogues; answered and directed to other offices thousands of telephone and in-person inquiries; and served as a clearinghouse for mail addressed simply to MIT. Head guide for the campus tours was Melissa Edoh '02. Terri Priest Nash trained 32 guides who conducted tours for 16,691 visitors, of whom 6,513 were prospective students, 2,058 were international visitors and the remaining general visitors. Terri also arranged short-term visits, which brought an additional 360 guests to campus, primarily from other countries.

Donald Ferland, Assistant to the Director, handled the arrangements for nearly 300 recruitment presentations by companies and other organizations that visit MIT under the auspices of the Office of Career Services and Preprofessional Advising.

The Director coordinated the logistics of the Millennium Ball in January, the Johnson Games 2000 in May, a retirement gathering for Dr. Arnold N. Weinberg, MIT's Medical Director since 1985, and the Institute's Annual Retirement Dinner in June.

Commencement activities began with the Hooding Ceremony for 400 doctoral degree recipients, held in Rockwell Cage the afternoon of 1 June. Chancellor Lawrence S. Bacow presided over this year's ceremony. The 134th Commencement Exercises, held on Friday, 2 June, featured an address by alumna Carleton "Carly" S. Fiorina, President and Chief Executive Officer of Hewlett-Packard Co.

Conference Services

The office of Conference Services manages the logistical arrangements for conferences and meetings sponsored by MIT faculty and staff. This past year, the Office coordinated 30 events, which brought more than 10,000 guests to campus. These events included, among others, the 24th International Herpes Virus Conference, the Interpreting Aalto Conference, the Siemens/Westinghouse Science and Technology Competition, the ILP Research Directors Annual Conference, and the Massachusetts State Special Olympics Summer Games.

Personnel

The center, under the direction of Gayle Gallagher, includes Donald Ferland, Assistant to the Director; Kathleen Barrett and Lee Corbett for information dissemination and visitor services; and Terri Priest Nash, Coordinator of Special Visits. The Conference Services staff is managed by Cathi Di Iulio Levine and includes Marie Seamon, Joy Hubbard, and Eva Cabone. Jeannie Lauricella continues to provide assistance on many fronts in the center. Last fall the center was pleased to welcome Joseph Coen, who is assisting with event coordination and visitor services.

Gayle M. Gallagher

NEWS OFFICE

The mission of the News Office is to achieve the highest level of public interest in MIT by finding and reporting newsworthy stories and photographs about MIT and its people; to encourage and assist reporters to develop their own stories here; to publish the official weekly newspaper, *Tech Talk*, the MIT News web site, and the monthly *MIT Research Digest*; to monitor internal and external developments that might bring favorable or unfavorable public attention; and to handle them with integrity in the best interests of the Institute.

During the year, the News Office published 151 news releases, more than 200 photographs, 33 issues of *Tech Talk*, and 10 issues of *MIT Research Digest*. The MIT News web page featured 222 articles and news releases as news briefs.

Top Stories

Fiscal Year 1999–2000 was full of notable events:

- History Professor John Dower won a Pulitzer Prize and virtually every major book award for his history of post-war Japan, *Embracing Defeat*.
- Robert Mundell, MIT Ph.D. '56, won the Nobel Prize in economics and became the 46th Nobel Prize winner affiliated with MIT as a teacher, researcher, student, or staff member.
- MIT launched a $1.5-billion capital campaign—and alumnus Kenan Sahin announced to a thunder-struck crowd a spur-of-the moment decision to pledge $100 million.
- Computer publisher Patrick J. McGovern Jr. and Lore Harp McGovern made a 20-year, $350-million commitment to establish an institute for brain research at MIT.
- MIT continued to strengthen its ties overseas with the establishment of the Cambridge-MIT Institute in partnership with the University of Cambridge and of MediaLab Europe in Dublin.
- MIT announced partnerships with DuPont, Hewlett-Packard, Microsoft, and Nanovation Technologies. These five- to seven-year agreements provide for aggregate support of $175 million for research and education.
- The Laboratory for Computer Science will conduct $50 million of research under the MIT Oxygen project, funded by a consortium of private corporations, to create a new breed of pervasive, human-centered computers devoted to serving people's needs.

Media Coverage

MIT research and other activities were the subject of thousands of articles and television or radio broadcasts over the year. During just one two-week period in October, there were 510 articles about the Institute in 143 media outlets. The Sahin and McGovern commitments generated the year's most extensive television coverage.

Thematically, of MIT's 151 news releases, 34 concerned applications of science and technology that are critical to society; 30 involved scientific discoveries; 27 involved excellence or the recognition of excellence; 14 involved the MIT and Cambridge community; seven involved fund-raising; six illustrated the Institute's tradition of hands-on learning; five concerned matters of racial or gender diversity; five concerned international collaborations; and 15 involved campus problems and the resolution of problems, including the tragic deaths of three students on campus.

Discoveries in biology and space science which were widely publicized included evidence that learned behaviors change the brain; that the part of the brain used for hearing can also learn to see; that an anti-aging gene's function may be tied to metabolism; the discovery of the closest black hole, only 1,600 light years away; and that the view inside Mars reveals rapid cooling and buried channels. Scientific and engineering applications that inspired wide coverage included an ultrasound technique that could eventually replace the drawing of blood via needles; the use of Star Wars' technology to treat breast cancer; non-invasive methods for early cancer diagnosis; advances in engineering heart tissue; a comprehensive assessment of the Kyoto Protocol on the environment; a scale to assess Earth-asteroid close encounters; the use of simple ocean measurements to predict hurricane intensity; new drugs for treating HIV; advances in the MIT plasmatron that may allow cars to operate on alternate fuels; and a robot that helps stroke victims recover.

On the Sunday before Commencement, the *Boston Globe Magazine* published a very positive 5,000-word article on Charles M. Vest's ten years as president of MIT.

The noted European photographer George Steinmetz took an outstanding series of photographs of MIT during a visit arranged by the News Office. The photos were the focus of an extraordinary 30-page spread in the German magazine *Geo* and became the focus for similar coverage in Italy and in the *Financial Times* of London.

Operations

The News Office began putting more emphasis on the web as a vehicle to get news quickly to the MIT community. The content of the MIT News site changes about three to four times a week, and the contents of *Tech Talk* appears on the web simultaneously with its print publication on Wednesday.

Since December, all News Office photography has been in color. *Tech Talk* and the *Research Digest* publish in black and white, but this change greatly enhances publication of News Office stories on the web.

Staff

The full-time News Office staff are Denise Brehm, staff writer and assistant editor of *Tech Talk*; Donna M. Coveney, assistant director/photojournalist; Myles P. Crowley, administrative assistant; Lisa Damtoft, editorial and graphics assistant; Patricia M. Foley, senior office assistant/receptionist; Deborah Halber, science writer; Mary Anne Hansen, administrative secretary; Robert J. Sales, associate director; Elizabeth A. Thomson, assistant director for science and engineering; Alice C. Waugh, assistant director and editor of *MIT Tech Talk*; and Sarah H. Wright, senior writer. We received part-time help from students throughout the year for the Hometown Bureau and related database work and filing. During the summer, Cambridge student Myra Zuleta worked with us. During the school year, we were aided by seniors Lia Rodriguez and Ricci Rivera, both biology majors.

More information about the News Office can be found at http://web.mit.edu/news/.

Kenneth D. Campbell

PUBLISHING SERVICES BUREAU

The mission of the Publishing Services Bureau (PSB) is to act as a single coordinated channel for publishing activities across the Institute, applying the principles of supplier consolidation, strategic planning, technological awareness, cost savings, excellence in design, continuous learning, and customer satisfaction.

Highlights of the Year

PSB continues its productive partnership with the Communications Office and Web Communications Services (WCS), which leads to the exchange of ideas and information about related business processes and aligned planning activities, providing seamless support interface for MIT customers in the area of electronic publishing and strategic print planning. Our office space provides an inviting professional environment for the combined staff to serve the needs of the MIT publishing community. Shared meeting space draws vendors and members of the MIT community for small and large group discussions regarding unique projects as well as publishing topics of broader interest.

PSB/WCS coordinated over 1,000 jobs, from publication planning and vendor selection to design, production, and printing. With the help of its database, PSB tracked all aspects of publishing activities for jobs passing through the bureau, creating a baseline for the analysis of design, production schedules, and printing costs as well as an archived job history.

Approximately $1.2 million was processed in print in fiscal year 2000 with an additional $1.9 million dollars channeled directly to MIT/PSB interim print partners. Jointly, PSB and WCS managed $664,000 in creative services, of which nearly $300,000 was for website design.

Throughout the year, PSB worked with 15 interim print partners, testing supplier consolidation assumptions and modeling best practice behaviors. Grid pricing was established for the production of letterhead and envelopes. PSB/WCS also developed partnerships with over 20 print and web design groups.

Strategic alliance with WCS produced "one-stop shopping" for MIT customers for coordinated print and web design and implementation. PSB has coordinated over 60 electronic publishing projects with WCS and continues to collaborate on variations of the main MIT home page.

Collaboration with the Communications Office has led to a relationship in which PSB plays a role as both a broker and a partner. In addition to advising Communications on their own publishing projects, both organizations have joined together to model and advise on effective publishing processes. Ongoing efforts include planning communication strategies for Student Services, the Graduate Students Office, and the Admissions Office.

PSB works with other campus partners—including CopyTech, Mail Services, and Document Services—to promote their services and establish smoother lines of communication and workflow.

Building on efforts in recent years to establish equity in MIT's institutional identity system, PSB began to develop an identity system that will reflect the Institute's mission and values while facilitating the operational handling of MIT's communications. Developments this year included focus groups with a number of Institute constituencies, the development of test templates for business papers, and preliminary sketches for graphic marks.

Future Plans

Future plans for the Bureau include the following:

- Remain committed to the promotion of good publishing practices exemplified by extraordinary design standards and economy of production.
- Continue to promote community understanding of both the PSB mission and good publishing practices through the use of its Web site, instructional seminars, community outreach initiatives, and joint Communications Office and WCS partnership.
- Establish partnerships with selected print and design vendors.
- Develop and establish an Institute-wide identity system implemented through incentives rather than mandates.
- Develop an on-line catalog system for the production of letterhead, envelopes, and business cards as well as develop templates for use by MIT publishers.

Personnel Changes

In the early spring, Marc Mancuso, senior staff assistant, left PSB to pursue his studies at the Museum School in Boston; at the beginning of the summer, VictorJosé Santana took a position as an art coordinator with the Chelsea Leadership Program at Roca. PSB welcomed to the staff Maryann Czerepak, procurement broker; Bara Blender, print/electronic broker; John Kramer, print/design broker; and Ayoka Drake, senior staff assistant.

More information about PSB can be found at http://web.mit.edu/psb/.

Bruce Bernstein

WEB COMMUNICATIONS SERVICES

Conveying MIT's message effectively to the world now requires a clear under-standing of both the technological and communications potential of the web. This year marked the consolidation of a strategic alliance between Information Systems and Public Relations Services (PRS). The group formerly called Campus Wide Information Systems (CWIS), part of Information Systems, changed its name to Web Communication Services (WCS); Suzana Lisanti, director of web communications and team leader, now reports jointly to Information Systems and PRS.

WCS publishes the official MIT web site (http://web.mit.edu/) and consults to the MIT community on strategic use of the web, interactive environments, best practices in web communications, information mapping, and web publishing technology.

Together, this past year WCS and the Publishing Services Bureau (PSB) coordinated over 60 web projects, from publication planning and vendor selection to design, production, and integration with the greater MIT web site. Web

site development worth $300,000 were managed through WCS and the PSB joint partnership. We collaborated with the Communications Office and the PSB on the MIT Organization Chart and created web templates for MIT's senior officers.

The WCS help desk answered 3,600 email queries to the official MIT site this past year and an additional 2,500 help-desk queries from the MIT community, helping clients manage their own web sites.

Increasingly, Web Communications consultation extends beyond individual web sites to participation in departmental and institutional planning efforts as well as assistance in the hiring process for web-related positions.

Official MIT Web Site

WCS publishes the official MIT web site and supports an MIT web presence comprising one million pages. This year the home page spotlighted 274 changing headlines, many accompanied by changing graphics that continue to receive praise from the viewers. We successfully negotiated for the URL http://www.mit.edu/ and achieved the goal of having it display the official MIT home page.

WCS facilitated the integration of information on the MIT web site, working to ensure the accuracy and completeness of Institute information available on the web, including the quality and professionalism of its presentation. WCS continued to define guidelines for effective use of the web at MIT, including usability, graphics, and accessibility guidelines.

This year, we began evaluating the MIT home page, gathering information for a redesign of the site that will promote the MIT identity, provide users with a greater ability to find MIT information, enhance services and processes at MIT with web-based applications, and make better use of content to showcase MIT's strengths.

Outreach and Training

WCS conducted monthly meetings of the MIT Web Publishers group, and provided additional classes on specialized topics such as web access reporting and advanced search engine classes. WCS wrote numerous articles on web publishing for the Information Systems newsletter.

Suzana Lisanti presented a paper on "Web Portals" at the Common Solutions conference at Stanford University, and Jag Patel presented a paper on "MIT's Web Publishing Infrastructure" at the Large Installation System

Administration conference in Seattle. Three members of the team serve as freshman advisors.

New Web Capabilities

WCS researched and advocated for Institute-wide web services such as a global search engine, web-based surveys, secure credit card processing, and an Institute events calendar along with colleagues from Information Systems and the PSB. We investigated HTML publishing tools and selected Macromedia Dreamweaver for the MIT community, acquiring a volume license for free distribution inside MIT.

Future Plans

Future plans include the following:

- Complete the evaluation and redesign of the official MIT web site.
- Continue to advise the MIT community strategic planning for information delivery and interactive web pages.
- Work to strengthen partnerships with the Communications Office, News Office, and PSB.
- Recommend guidelines for commercial activity on MIT web sites.
- Support the Council on Educational Technology with web communications expertise.

Personnel

Joanne Costello joined Web Communication Services, and will focus on guidelines for the MIT web site and in providing web site consulting and design brokering to MIT clients.

More information about WCS can be found at http://web.mit.edu/services.html.

Suzana Lisanti

OFFICE OF THE SECRETARY OF THE CORPORATION

One of the Institute's four corporate officers, the Secretary of the Corporation is responsible for overseeing the operations of the Corporation, MIT's board of trustees, including membership and standing committees, and, through the Office of the Secretary of the Corporation, quarterly meetings of the board, and 30 Corporation visiting committees that conduct biennial reviews of the Institute's academic and research programs. The Secretary also serves as secretary of the Executive and Membership Committees, Recording Officer of the Corporation, and joint signatory with the President in the awarding of academic degrees.

CORPORATION MEETINGS

Orientation Program and Annual Meeting

On September 30, 1999, an orientation program was held for new members of the Corporation. In the evening, new members and their spouses and guests were joined by members of the Executive, Membership, and Auditing Committees for a reception and dinner.

At the annual meeting on October 1, 1999, the Corporation approved the action of the President in the awarding of September degrees, and, as part of the report of the Membership Committee, voted to approve the list of nominated members of the visiting committees and seven new visiting committee chairs. Members heard reports from the President, the Treasurer, and the Vice President for Resource Development, and from the chairs of the Auditing Committee and three visiting committees. Memorial Resolutions on Life Member Emeritus J. Kenneth Jamieson were also presented to the membership.

December Meeting

At the meeting on December 3, 1999, the Corporation heard reports from the President and the chairs of the Membership Committee and five visiting committees. Members also heard Remarks on the transfer of Life Member Frank Press to Life Member Emeritus.

March Meeting

At the next quarterly meeting on March 3, 2000, the Corporation heard Remarks on the transfer of Edward E. David, Jr. to Life Member Emeritus, and approved the action of the President in the awarding of February degrees. Reports were presented by the President, the President of the Association of Alumni and Alumnae of MIT, and by the chairs of the Corporation Joint Advisory Committee on Institute-Wide Affairs, Membership Committee, Screening Committee, and three visiting committees. At the Corporation luncheon, CJAC chair Elisabeth A. Stock led a discussion that focused on impressions of the dinner held the previous evening, which was designed to foster interaction between Corporation members and students in an informal setting.

Commencement Meeting

The final quarterly meeting of the academic year was held on June 2, 2000, prior to Commencement exercises, at which the speaker was Carleton "Carly" S. Fiorina, President and Chief Executive Officer of Hewlett Packard Company. At the meeting, the Corporation approved the action of the President in the awarding of June degrees, and approved three new degree programs. The Corporation elected new Corporation members, members of the standing committees and committees of annual recurrence, chairs of the visiting committees, and members of the Corporation Development Committee. Resolutions were read to honor five members completing their terms of service on the Corporation. Remarks on the transfer to Life Member Emeritus/a were read for Life Members James A. Levitan '45 and Emily V. Wade '45. Members heard reports from the President and the chairs of the Membership Committee, Screening Committee, and three visiting committees. Corporation members participated in the academic procession to Killian Court for Commencement exercises, for which Emily V. Wade '45 served as Corporation Marshal.

CORPORATION MEMBERSHIP

Completed service effective June 30, 2000: George N. Butzow, John M. Hennessy, Mark E. Lundstrom, Antonia D. Schuman, R. Gary Schweikhardt.

Resigned from the Corporation effective June 30, 2000: Gerhard H. Schulmeyer.

Retired from office effective August 31, 1999: Herbert P. Wilkins, Chief Justice of the Supreme Judicial Court, Commonwealth of Massachusetts.

Elected to a five-year term effective July 1, 2000: Dedric A. Carter, John K. Castle, Arthur Gelb, Barbara A. Gilchrest, Brian G. R. Hughes, James A. Lash, Linda C. Sharpe, John A. Thain.

Elected to complete two unexpired terms effective July 1, 2000: Gordon M. Binder, John A. Thain.

Elected Life Member effective July 1, 2000: Judy C. Lewent, A. Neil Pappalardo.

Ex officio Member for a one-year term effective July 1, 2000: Paul Rudovsky, 2000–2001 President of the Association of Alumni and Alumnae of MIT.

Ex officio Member effective September 1, 1999: Margaret H. Marshall, Chief Justice of the Supreme Judicial Court, Commonwealth of Massachusetts.

Transferred to Life Member Emeritus: Frank Press (December 1999); Edward E. David, Jr. (January 2000); James A. Levitan (March 2000); Emily V. Wade (May 2000).

Death: J. Kenneth Jamieson (September 26, 1999).

CORPORATION COMMITTEES

Advisory Committee on Shareholder Responsibility

The Advisory Committee on Shareholder Responsibility did not meet as a group in 1999–2000. The Treasurer monitors votes in accordance with guidelines previously established by the Committee and is charged with convening the Committee if new issues arise during the year.

Auditing Committee

Meetings of the Auditing Committee were held on September 30, 1999 and March 2, 2000. In attendance were the Auditing Committee members, representatives from PricewaterhouseCoopers, personnel from the MIT Audit Division, various MIT financial staff and certain invited members of the MIT administration.

The fall meeting included a presentation on the financial statements for Fiscal Year 1999, a report from the Institute's internal auditors, and a discussion about the management letter from PricewaterhouseCoopers. A major focus of the meeting was a complete update on the detailed plans to avoid any material failures or disruptions as a result of Y2K issues.

The spring meeting included a presentation on PricewaterhouseCoopers audit plans for Fiscal Year 2000, a report on the successful results of the Y2K effort, and an update on compliance to various government regulations. Deborah L. Fisher was introduced as the new Institute Auditor and head of the MIT Audit Division.

Corporation Joint Advisory Committee on Institute-Wide Affairs

The Corporation Joint Advisory Committee on Institute-Wide Affairs (CJAC) held three meetings during the year. Discussions focused on issues of concern that were submitted by student members, including the need for improved graduate advising; increased diversity among graduate students; and greater opportunities for expanding the social side of student life at MIT. Dinners in student residences to bring Corporation members closer to the students in their own environment were begun by CJAC this year, culminating with a meeting and dinner in Baker House. In setting an example to foster community, faculty will be invited to future CJAC dinners. One meeting, held jointly with the Screening Committee, also focused on the process of nomination and election to the Corporation. The chair, Elisabeth A. Stock, presented a report of CJAC's activities to the Corporation at the March meeting.

Corporation Development Committee

Activities of the Corporation Development Committee are covered in the annual report of the Vice President for Resource Development, under the Office of Individual Giving.

Executive Committee

The Executive Committee held ten meetings during the past year. As in 1998–99, there was substantial discussion of budget processes, financial planning, and the management and enhancement of the Institute's resources. Other topics on the Committee's agenda included undergraduate education and student life; student recruitment and admissions and financial aid policies; the physical development of the campus; and the governmental, industrial, and international sponsorship of programs of instruction and research.

Investment Committee
The Investment Committee held three regularly scheduled meetings during Fiscal Year 2000 under the chairmanship of Samuel W. Bodman.

The Wellington Management Company of Boston remained the primary investment manager and advisor for publicly traded securities, both domestic and international. The Institute maintained the program, managed by four other investment management firms, of equity investments in smaller capitalization companies and through two other investment management firms of investments in international equities. The program for domestic and international alternative investments to publicly traded securities was continued. These alternative investments including venture capital, private capital, real estate, event arbitrage, and distressed debt are typically managed by several investment managers through pooled investment funds.

Membership Committee
The Membership Committee held three meetings during the academic year to discuss matters concerning membership on the Corporation, and nominations to various Corporation standing committees and committees of annual recurrence.

Corporation Screening Committee for Nomination of Recent Graduates
The Corporation Screening Committee for Nomination of Recent Graduates, in collaboration with CJAC, held a joint dinner meeting for students on September 30, 1999, in part to explain the nomination and election process for membership on the Corporation. The committee met via two teleconferences in January and February 2000 to review all nominees. From a group of 75 candidates, the committee selected eleven for the ballot. Mr. Dedric A. Carter '98 received the nomination and was elected in June to serve a five-year term on the Corporation.

Visiting Committees
Fifteen Corporation Visiting Committees convened for regular two-day meetings during the academic year 1999–2000: Athletics, Physical Education, and Recreation; Bioengineering and Environmental Health; Dean of Students and Undergraduate Education; Earth, Atmospheric, and Planetary Sciences; Humanities; Linguistics and Philosophy; Materials Science and Engineering; Mathematics; Mechanical Engineering; Media Laboratory and Media Arts and Sciences; Nuclear Engineering; Sloan School of Management; Sponsored Research; Urban Studies and Planning; Whitaker College. In addition, a special one-day meeting was held for the visiting committee for the Engineering Systems Division.

In 1999–2000, the Institute's 30 visiting committees were comprised of 413 persons and 536 membership positions: 66 Corporation members filled 165 slots; 191 presidential nominees filled 200 slots; 166 alumni nominees filled 171 slots. (Ten people each filled both a presidential nominee slot and an alumni nominee slot.)

Women comprised 24 percent of the visiting committee membership, and minorities 18 percent; 54 percent of the members were affiliated with corporations, 44 percent with academia, 8 percent with government and foundations, and 2 percent with other organizations.

Office Activities and Personnel
The preparation of *A Planning Guide for the Corporation Visiting Committees*; an historical database update project, and the development of the Corporation Office web page were some of the additional activities accomplished this year by the staff of the Corporation Office under the effective direction of Susan A. Lester, Associate Secretary of the Corporation, in addition to the ongoing management responsibility for the quarterly meetings of the Corporation and the 16 visiting committees that convened in 1999–2000. Del Ray Cross left the Corporation Office in May to relocate to San Francisco. Michelle D. Hinkle continues to provide highly competent assistance in support of the Office and the members of the Corporation.

Kathryn Willmore

VICE PRESIDENT FOR HUMAN RESOURCES AND EQUAL OPPORTUNITY OFFICER

I am pleased to have joined MIT last October and deeply appreciate the welcome I have received from all corners of the Institute and the legacy of excellent human resources practices left by Joan Rice, my predecessor. As well as being a year of transition for HR and Medical Department staff, it was also a year of significant accomplishments, as the following reports demonstrate.

The Human Resources Leadership Team organized our work around four major goals: to increase MIT staff's diversity and enhance recruitment capabilities; to integrate competency-based HR practices into the management of people in the Institute; to improve communications about HR both within the department and to our external clients; and to develop an approach to HR technology that supports the implementation of the HR/Payroll system. Work teams have been formed to address each of these areas, drawing on both HR staff as well as interested representatives from a variety of departments, labs, and centers.

Responding to recommendations from the HRPD report of 1998 and urging from the Senior Management Group, I appointed an interdisciplinary task force to design a Rewards and Recognition program. The task force completed its work in June. The plan is being refined and tested with various organizational groups and will be rolled out in the fall, 2000.

The Implementation Resources Team has completed its pilots, and the competency work is being integrated into daily HR practices. Barbara Peacock-Coady of this team, working with the Performance Consulting and Training group, will expand our career counseling capabilities by opening an office specifically to address employees' development needs.

With Dr. Arnold Weinberg, Medical Director, planning his retirement in the summer of 2000, we convened a search committee chaired by Professor Henry Jacoby of the Sloan School. The committee unanimously recommended the appointment of Dr. William A. Kettyle, currently Associate Medical Director, who will be promoted to Medical Director effective August 1. Celebrations were held to honor Dr. Weinberg for his extraordinary leadership of the Medical Department. We all are grateful for his many contributions to medical excellence and teaching, overseeing a broad range of patients and staff, and linking MIT to high-level medical services throughout the greater Boston area. His exceptional work leaves a strong department in Dr. Kettyle's capable hands.

The Working Group, with sponsorship from Human Resources, celebrated its 25th anniversary as an organization for support staff within MIT. They conducted a variety of educational and social events honoring their history and current members.

As of June 1, 2000, of the total of 44 administrative staff in HR, 9 (20%) are members of minority groups and 30 (68%) are women. (This headcount includes the Implementation Resources Team which was incorporated into HR this year and some other reorganization of accounts.) In 1999, of 32 administrative staff, 10 (31%) were minorities and 20 (63%) were women.

As of June 1, 2000, of the total of 22 support staff in HR, 9 (41 %) are members of minority groups and 19 (86 %) are women. In 1999, of 20 support staff, 6 (30%) were minorities and 16 (80%) were women.

Laura Avakian

MEDICAL DEPARTMENT

Providing low barrier, high quality care for the MIT community remains the focus of the activities of the MIT Medical Department. In addition to providing onsite primary and specialty care, members of the Department also coordinate care for members of the community at nearby secondary and tertiary care facilities. Our relationships with local teaching hospitals provide world-class care in a coordinated, convenient, caring style. In addition, through a number of programs and intra-campus relationships, the Department provides care and advice for the MIT community on a wide variety of issues.

A number of important accomplishments and continuing initiatives marked this past year.

MIT Medical/Lexington, a point-of-service, clinical care and exercise facility on the grounds of the Lincoln Laboratory opened in the fall of 1999. Staffed by internists, pediatricians, and nurse clinicians trained in Pediatrics

and Family Medicine, care is provided not only to members of the MIT community who work at Lincoln Laboratory, but also to their families and to members of the MIT community who reside in surrounding communities.

The ComMITment to Care program, our "customer service" initiative, has begun to have an impact on both the operations of the Department and on the style of care delivery. Goals and standards have been identified and implementation along several lines has progressed. The first round of ComMITment to Care awards was presented this spring.

In November, MIT Medical was surveyed by the Joint Commission on Accreditation of Healthcare Organizations and the Department received an excellent score. A few "Type 1" recommendations were made by the surveyors; these fell into administrative areas and none focused on patient care. A follow-up report was submitted to the Commission in June documenting the corrective actions taken based on the surveyors' recommendations.

The department's laboratory was also inspected during the year and passed the College of American Pathologists' survey with high marks.

A new strategic planning initiative has begun. Starting with a careful review of the services we provide, the services available in the Boston area, and the needs of the community that we serve, a process of evaluation and planning is under way. One goal is to set up a system of planning that allows a more continuous approach to this important endeavor.

Student care and health education continue to be major concerns of the Department. The Health Education section coordinates, initiates and supports a variety of student-friendly educational programs and plays a major role, when appropriate, in connecting students to clinical care. Providing support to the MIT community at the time of a campus tragedy is an import function of the Medical Department.

A computer based scheduling system has been implemented that allows for decentralized scheduling of patient visits. The system has the potential to make care more available and convenient for the community that we serve. The approach to an electronic medical record has made great progress during the year. Laboratory results are available on computer and trends and patterns of change can be displayed both in tabular and graphic form.

The appointment and arrival of Dr. Jay Afrow as Chief of the Dental Service has led to significant changes in the Dental Service with reduced queues and improved financial status.

The Environmental Medical Services has moved from the Medical Department to the Office of Environmental Programs and Risk Management in a reorganization designed to improve the provision of these important services.

The first department-wide meeting was held in October. The gathering was a great success with presentations of departmental accomplishments and plans and an opportunity for a discussion of student health issues.

Dr. Weinberg announced his retirement, effective June 30, 2000. A search committee was established and an intensive search for a new director has begun.

The arrival of Ms. Laura Avakian as Vice President for Human Resources has had a very positive impact on the Department. Her knowledge of the health care field is a great asset for both the Medical Department and the Institute.

MEDICAL CARE ACTIVITIES

Dental Service, Jay Afrow, D.M.D., M.H.A., Chief

Dr. Afrow replaced Dr. Stoute in May, 2000, working approximately half time in patient care and the other half in administration. Dr. Afrow has decreased the queue for appointments, improved the administrative function and enhanced staff morale. Significant progress has been made both in the availability of care and in the fiscal foundation of the Dental Service.

Medical Service, William M. Kettyle, M.D., Chief

With 12 internists, four of whom have subspecialty training or certification, care is provided on a 24-hour-a-day, 7-day-a week basis at three venues – the MIT Cambridge facility, the Lincoln Laboratory center, and at the Massachusetts General Hospital. During the year, Dr. David Diamond was appointed Physician Coordinator for the Lexington facility. In addition, many members of the Medical Service staff actively participate in campus activities and teach programs at Harvard Medical School, the HST program, and at the Massachusetts General Hospital.

After Hours Service, Howard M. Heller, M.D.
The After Hours Service continues to provide 24-hour, 7-day-a-week, on-site physician coverage to members of the MIT community as well as visitors to MIT. Telephone advice and guidance are also available at all times. The service continues to be staffed primarily by licensed physicians who hold full-time appointments at the Massachusetts General Hospital, Brigham and Women's Hospital, or Children's Hospital.

Several major changes have been made over the past year in an effort to improve service to patients including: the appointment of Janice Puibello, R.N., C.S. as full-time Coordinator of Urgent Care allowing for improved coordination of follow-up care; and the installation of an automated medication dispensing machine (Pyxis) to reduce the risk of dosing errors, improve inventory monitoring, and increase the variety of available medications.

Inpatient Medical Services, William A. Ruth, M.D.
The Inpatient Unit continues to play a vital role in the care of MIT patients. From July 1999 through June 2000 there were 712 admissions of which 39% were students, 32% were Health Plan members, and 16% were Medicare recipients. The Clinical Research Center had 84 research admissions for a variety of studies.

During the year, Dr. Ruth replaced Dr. Shiang as physician overseer and Cathleen Dwyer, R.N. became nurse in charge. Physical improvements included installation of door shades for patient rooms, purchase of new solarium furniture (thanks to a patient donation), and installation of a hallway sink. We are working with an acoustical engineer to minimize noise around the nursing station.

Physical therapy services are now provided in-house by the MGH Physical Therapy Department under a contract that should decrease costs while improving restorative services.

Obstetrics and Gynecology Service, Lori A. Wroble, M.D., Chief
The Department received 8,641 patient visits during the past year and performed 161 deliveries and 45 gynecologic surgeries.

In October, Dr. Susan Hellerstein replaced Dr. Finlayson after his retirement in June. There are three full-time physicians and one part-time physician, as well as two nurse practitioners and two medical assistants. Patient volume has already increased slightly and wait times for next appointments have dropped. We anticipate that this trend will continue.

All our practitioners continue to participate actively in community activities including IAP lectures, pre-med advising, MedLINK advising, participating in the HST program's introduction to clinical medicine and the HMS Primary Care Mentorship Program, precepting MGH nurse practitioner students, and supervising residents at the Brigham and Women's Gyn Clinic. Most of our providers also participate actively in Department committees and initiatives.

Pediatrics, Mark A. Goldstein, M.D., Chief
The Pediatric Service developed a plan to staff the pediatric component of the Lexington office of the Medical Department. A half-time pediatrician/cardiologist was hired, as well as a half-time pediatric nurse practitioner. Two senior pediatricians provide the remainder of the coverage. By year's end, bookings at the Lexington site were increasing and patient satisfaction was felt to be high.

The immunization quality improvement project, coordinated by Ms. Bartels, was completed and presented at the JCAHO survey. The overall immunization rate of 2-year-old children increased significantly after identification of issues and corrective measures were put in place. A new quality improvement project was initiated during the year, which focuses on care of asthmatic children.

Efforts were increased to communicate to our international families in their native languages. Written materials in Japanese, Spanish, Portuguese, Chinese and Korean were made available in several different subjects.

Educational efforts were increased in the MIT community as well as in local, regional and national audiences. Ms. Bartels served on several MIT committees to promote the care of children on campus. Ms. Lyden and Dr. Goldstein delivered presentations at the Lexington site on pediatric issues. Dr. Goldstein, as Chair of the Massachusetts Medical Society Committee on Student Health and Sports Medicine, continued efforts to enlighten the public about alcohol and tobacco abuse in children and adolescents. His book, *Boys Into Men: Staying Healthy Through the Teen Years*, was completed during the year and will be published in the summer of 2000. Written for adolescent boys, it reviews many of the problems and issues of adolescence and has been based on many of the experiences from the patients of the Medical Department.

Student Health, Mark A. Goldstein, M.D., Chief
The Department continues to offer a warm welcome to entering freshmen. An ice cream social, coordinated by Judy DeGraan, was a huge success. Entering freshmen and Medical Department staff mingled in an informal setting shortly after the students' arrival in August.

Meningococcal disease is a rare, but very serious infection that can cause death or serious disability to college-age individuals. After review of both the research literature and current recommendations from the Centers for Disease Control and Prevention, the MIT Medical Department became one of the first college health services to strongly recommend that all freshmen arriving in 2000 receive this vaccination. Thus far, this recommendation has been well received by incoming students and their families.

Educational and preventive measures to diminish the use of alcohol have continued on campus and these efforts have been noted in local and state publications. Dr. Goldstein was asked to present information about these actions at local medical meetings and courses, as well as at the national meeting of the Society for Adolescent Medicine.

Planning continues on how best to serve the student patients of the Medical Department. Student needs, life styles and medical problems differ from those of other members of the MIT community. For example, communication with students is much more electronically based and, as a result, procedures were put into place to utilize E-mail in medical communications. Students also tend to use medical services after regular hours and on weekends. Procedures have been modified to ensure proper follow up with students. Finally, a combination of a primary care physician connection and a walk-in clinic for episodic illness is being reviewed for student patients.

Health Education Service, Margaret S. Ross, M.D., Physician Liaison
This past year saw the departure of health educators Tracy Desovich and Rosanne Guerriero, the retirement of program coordinator Sally Ciampa, and the arrival of new health educators Gina Baral and Marlisa Febbriello. In addition, a search is currently under way for a Director to serve as overall manager for the service.

Despite these staffing changes, the work of the service has been ongoing. Wellness classes (48) were held in both Cambridge and Lexington, and 53 childbirth and parenting classes were offered in Cambridge. During IAP, 51 talks were presented to 758 participants. MedSTOP, in the Student Center, continues to be a popular spot distributing pamphlets on relationships, mental health and stress, sexual health, drugs and sexual identity. The MedLINK program now includes 83 individuals who serve in 25 living groups. Logs are being kept to monitor interactions among students and MedLINKS. Campus-wide MedLINK events included AIDS awareness, KISS, eating disorders awareness, RSI, safe spring break, and de-stress for success.

In summary, the Service continues to serve its twofold mission of education to both the student population and the overall MIT community.

Mental Health Service, Peter A. Reich, M.D., Chief
The Mental Health Service had one of its busiest years, partly because of the success of the new walk-in program, and partly because of an unusually high number of seriously disturbed patients. Although difficult to document, it is the impression of the veteran providers that the student patients seen this year have had a greater than usual level of pathology. This impression is shared by other directors of mental health services at eastern universities and has no obvious explanation.

In response to student concerns about waits for appointments, a walk-in service was started in October, 1999. Every weekday afternoon one clinician with a back-up colleague is available to see all comers. Within a few weeks the program was being actively used and approximately 80% of the walk-in patients have been students (many of whom are new to the service).

Two new psychiatrists joined the service. Adam Silk, M.D. is board certified in psychiatry and in substance abuse, and has a special interest in the problem of alcohol use in adolescents. Bina Patel, M.D. is trained in both adult and child psychiatry and, as an Asian-American with strong ties to the Indian culture, is interested in reaching out to students from that subcontinent. After 20 years with the Service, Eric Chivian, M.D. resigned to assume full-time leadership of a program he developed at Harvard Medical School on the impact of environmental degradation on world health. Six trainees in various disciplines participated in the activities of the Service this year. The Wives' Group has changed its name to Spouses and Partners @ MIT. Under the leadership of Jessica Barton, LICSW, this large-scale support network for the international community at MIT continues to flourish.

Together with leaders from the Deans' office, Drs. Reich and Ross have formed a new committee to consider the special problems of students who are having chronic difficulties adjusting to MIT. Through the ongoing review of cases, this committee hopes to help establish guidelines for the management of difficult students.

Surgical Services, Lawrence T. Geoghegan, M.D., Chief
Three general surgeons and three orthopedists, together with coverage systems based at the Massachusetts General Hospital, provide round-the-clock surgical and orthopedic care and consultation. A number of minor procedures are done at the Cambridge facility, while more complicated procedures and all those requiring general anesthesia are done at the Massachusetts General Hospital. Sensitive, efficient, coordinated care for women with breast problems continues to be a major focus of the general surgical service. Sports injuries and their management remain an important function of the orthopedic service. There were no personnel changes during the year.

Nursing Service, Laureen K. Gray, R.N., C.S., Chief
The Nursing Service continues to provide clinical care on a 24-hour, 7-day-a-week basis. This was a year of transition and growth with four new nurses recruited and hired. These include a family and pediatric nurse practitioner to staff MIT Medical/Lexington, an occupational health nurse practitioner/infection control coordinator, and a performance improvement coordinator who will work collaboratively with all members of the Department in identifying and facilitating performance improvement initiatives. The Inpatient Unit has a new nurse manager and continues to provide quality care to patients of the MIT community.

Our outreach efforts include participation in freshman orientation, new student registration and clinical support during commencement ceremonies, flu vaccine clinics in the fall, participation in IAP activities, and collaborative outreach programs with our Health Education Department, providing information to our community of students. Several nurse practitioners precepted graduate nursing students from the MGH Institute of Health Professions and other academic institutions in the Boston area. The Nursing Continuing Education Committee organized the annual Nursing Conference Day, which focused on adolescent and student health issues.

OTHER ACTIVITIES
Clinical Research Center, Lee H. Schwamm, M.D., Associate Director
This year, the Clinical Research Center established a more structured relationship with the Massachusetts General Hospital's CRC and this relationship has, in fact, been highly successful. The reputations of the two CRCs are excellent and the strengths of each institution complement those of the other. The CRC continues to report to the Medical Department for medical and patient care matters, including licensure and laboratory support. Representatives from the CRC serve on the major committees of the Medical Department including the Medical Executive Committee. During this fiscal year, the CRC overnight admissions to the Medical Department totaled 84.

MIT Medical/Lexington, David V. Diamond, M.D.
The MIT Medical/Lexington clinic opened on November 1, 1999 in a fully renovated Health and Wellness Center building on the grounds of Lincoln Laboratory. Its goal is to provide convenient access to the Medical Department to current and potential future members of the MIT Health Plans as well as for the employees of Lincoln Laboratory. During the first 8 months of operation, details of support systems and clinical staffing have been evolving to allow for the efficient delivery of health care at this new facility. We have seen a 20% increase in visits with approximately 500 clinical encounters in June, 2000. General internal medicine and pediatric services are now offered, as well as access to providers with expertise in cardiology, infectious diseases, environmental and occupational medicine, and endocrinology. Health Education is also involved in arranging a pediatric lecture series and supplying patient educational materials. Depending on demand and staffing support, additional clinical services in orthopedics, obstetrics and ophthalmology may be added, as well as a limited expansion of hours.

Clinical Operations and Administration, William M. Kettyle, M.D., Associate Medial Director
Providing excellent health care at reasonable cost for the students, faculty and staff of the Institute continues to be the major goal of the Medical Department. Expanded hours of operation and the addition of services at the MIT Medical/Lexington site has resulted in more convenient availability of services for our community. Evening hours and weekend appointments continue to be popular with our patients. Efforts to streamline patient scheduling procedures continue in an effort to decrease waiting times and improve access to clinical care. To this end, a new information system went into operation in the fall of 1999.

Affiliations with the Partners HealthCare System and the Massachusetts General Hospital enhance access for our community to outstanding tertiary care when needed. Our quality improvement program has been reviewed and improved to make it more responsive to the needs of our patients.

Members of the Medical Department actively participate in many campus activities such as pre-med advising, MedLINK mentoring, HST teaching, and IAP program participation. And, a number of members of the Department have been involved in continuing efforts to provide education, care and advice with regard to issues surrounding the use of drugs and alcohol in our community.

MIT Health Plans, Mary E. Murray, Manager, Financial Services
A search is under way for a new Director of Finance and Health Plans following the retirement of Mary Smith in the spring. Her responsibilities have been assumed temporarily by other staff in the Department.

Enrollment, claims management and payment services have been thoroughly reviewed in preparation for the implementation of a new, more comprehensive computer system. The new system should both improve service for the patients of MIT Medical and also provide much more data for management and fiscal reporting.

In addition, the Health Plans team is working to ensure compliance with the Health Insurance Portability and Accountability Act (HIPAA). This legislation deals with the integrity of data systems and the confidentiality of records housed within them, as well as paper medical and financial records. New HCFA regulations have also been the subject of significant activity and Eileen O'Keefe has been appointed Compliance Officer.

Marketing the Health Plans and the clinical care available at MIT Medical has continued. Those eligible for care who reside in the Lexington area remain an important focus of our marketing activities. We hope this site will increase our patient base during the next open enrollment period.

Administrative Operations and Management, Annette Jacobs, Executive Director
The administrative area is in the midst of transition in two major leadership positions—the Director of Information Systems and the Director of Finance and Health Plans. Recruitment efforts are under way with the expectation that the health plans position will be filled by early fall. Due to the economy and the job market, the search for the information systems director might take longer.

The computer system implementation continues with many administrative staff splitting their time between ongoing operational responsibilities and systems implementation activities. The next phase includes applications that affect Finance and Health Plans, patient registration, medical records and the pharmacy. To date, we have successfully implemented patient scheduling and a laboratory interface, including results reporting.

As part of the ComMITment to Care program, ongoing random patient surveys have begun. The results will help us with individual staff development plans and with general department training, due to start in the fall. Providers will be trained in provider/patient interaction; other staff will learn general customer service skill building.

MIT Medical/Lexington opened in November and we continue to work on administrative details to assure excellent support of providers and patients at that facility. This site will be a major focus of marketing activities for the Health Plans during the Open Enrollment period and the coming year.

At the suggestion of the JCAHO, we continue to improve our staff performance evaluation process and to use this activity to help inform us regarding department-wide skill building and training needs.

Appointments and Terminations: June 1, 1999 through May 31, 2000

Appointments

Afrow, Jay	05/01/00	Chief of Dental Services
Amsler, Linda	09/08/99	Triage Nurse
Baral, Gina	01/01/00	Assistant Health Educator
Egler, Leslie	09/08/99	Psychologist
Febbriello, Marlisa	10/18/99	Health Educator
Hellerstein, Susan	10/04/99	Obstetrician/Gynecologist
Hinderlie, Holly	09/08/99	Psychologist
Joseph, Jocelyn	09/01/99	Pediatrician
Lloyd, John	07/01/99	Psychiatrist
Long, Patricia	04/03/00	Performance Improvement Coordinator
Lyden, Michelle	09/21/99	Pediatric Nurse Practitioner
Need, Laura	10/01/99	Pediatrician
Pasciuto, Linda	03/27/00	Inpatient Nurse
Patel, Bina	09/13/99	Psychiatrist
Puibello, Janis	09/13/99	Nurse Coordinator (Urgent Care)
Sigman, Deborah	07/12/99	Nurse Coordinator (MIT Medical/Lexington)
Silk, Adam	09/07/99	Psychiatrist

Terminations

Brown, Sandra	07/01/99	Social Worker
Cabael, Felian	07/19/99	Dentist
Cantin, Monique	08/03/99	Nurse Practitioner (MIT Medical/Lexington)
Ciampa, Sally	09/30/99	Program Coordinator
Desovich, Tracy	06/16/99	Health Educator
Finlayson, William	06/30/99	Obstetrician/Gynecologist
Guerriero, Rosanne	03/28/00	Health Educator
Goldfinger, David	08/31/99	Psychologist
Lightfoot, John	03/17/00	Director, Medical Information Systems
McClean, Quinn	07/02/99	Nurse Practitioner
Mirsalimi, Hamid	08/31/99	Psychologist
Niuikian, Khadjik	02/25/00	Dentist
O'Brien, Patricia	07/23/99	Triage Nurse
Powers, Janet	07/09/99	Inpatient Nurse
Smith, Mary	05/26/00	Director, Finance and Health Plans

Change

Dwyer, Cathleen	01/01/00	Nurse Manager, Inpatient Service (promotion)
Diamond, David	01/01/00	Physician Coordinator, MIT Medical/Lexington (Supplemental Appointment)

Important personnel changes, the opening of the Lexington satellite facility at Lincoln Laboratory, and the successful completion of the JCAHO survey marked the past year. The personnel changes offer the opportunity for new ideas and skills to be added to the Department. The Lexington center will increase the availability of services for the MIT community, and the successful JCAHO survey demonstrates that our clinical systems, organization and care delivery meet the highest standards.

Our staff and leadership are dedicated to providing the highest quality care and support for the MIT community. The vital work of Annette Jacobs, Laureen Gray, Anthony Rogers, Mary Smith and Peter Reich provide the foundation for a care system that we feel well serves the needs of the MIT community.

William M. Kettyle, Arnold N. Weinberg

AFFIRMATIVE ACTION/EQUAL OPPORTUNITY AND DIVERSITY

The Director of Affirmative Action/Equal Opportunity/Diversity Programs functions in a variety of ways to support the Institute's departments, laboratories and centers in these areas. The primary focus of activities is to assist in recruitment, hiring, advancement, and retention of underrepresented minorities and women; and to develop strategies to promote and enhance understanding, sensitivity and acceptance for diversity and the valuing of differences among students, staff and faculty within the MIT community.

The "Intuitively Obvious" video series, developed by Clarence Williams, Special Assistant to the President, continues to be used to elicit lively discussions and increased awareness. Those who have participated have gained a deeper understanding of the source and nature of many of the issues and concerns that revolve around race, ethnicity and gender interactions at MIT. The Director has continued her partnership with the Assistant Director for the Department of Facilities to complete the delivery of Diversity Training Classes to the administrative, support and service staff of that department. This class, one of several offerings from the Facilities' Learning and Performance Training Guide, promoted a positive awareness and acceptance of diversity within Facilities.

The Director continued membership on the Committee for Campus Race Relations and has remained in the role of co-chair for the Education Sub-committee. This sub-committee has collaborated this year with other members of CCRR to support the development of additional video materials that depict the diversity-related experiences of MIT members within our community for educational purposes. Through this collective effort, another taping of student conversations about their experiences surrounding diversity issues at the Institute and a video taping of interviews with a cross-section of white members of the community on the subject were produced. These newest videos will be used to further educate members of the community. The education focus of CCRR provided the basis for a proposal to and special funding from President Vest for seed money to develop a repository of diversity educational/training materials. Diversity educational objectives were also the focus of the sub-committee's submission of a preliminary proposal for a Ford Foundation Grant geared to support higher educational diversity initiatives. The efforts for grant funding for support to these efforts will continue. The educational resources and materials made available through CCRR to groups within MIT are intended to support the reduction of affirmative action, equal opportunity and diversity-related misunderstandings and potential violations.

In support of MIT's minority recruitment efforts, the office has provided assistance to DLCs for position openings, has expanded participation in local job fairs and special interest conferences for contact with qualified applicants, and has maintained affiliation with special-interest organizations for networking opportunities. These activities have increased the numbers of minority applicants on the WebHire applicant database, and together with actions taken by the Human Resources Officers, have enhanced opportunities to attract and hire underrepresented minorities. Diversity and Recruitment have been identified as one of four areas within Human Resources to be explored in depth by the HR Leadership Team. The Director is a co-leader for the investigation of the Diversity/Recruitment Initiative. The process has involved the participation of representatives from several of the departments, laboratories and centers across the Institute and two separate working teams are focused on each of these two areas. The intent of this effort is to conduct the research that will produce information and recommendations that will lead to improvements across the Institute through the application of best practices in recruitment and diversity.

The Director participated in the development of the Formal Employee Complaint Guide and continued to investigate and provide mediation support to concerns raised by employees involving gender, race or cultural issues. The 1999–2000 MIT Affirmative Action Plan (AAP) was produced and disseminated to the academic and administrative management staff of the Institute in July 2000. The upgraded system, PRI AAPlanner5 Program, has been installed and debugged and was used to develop the current Plan. The *Tech Talk* Supplement was also printed and distributed during July 2000. The Office continues to modify and streamline the contents of the MIT AAP to increase its functional use as a reference document to track and monitor affirmative efforts and progress toward goals.

Regina A. Caines

BENEFITS AND SYSTEMS

FAMILY RESOURCE CENTER

The Family Resource Center provides a broad range of work/life services including assistance with child care and children's schooling, parenting concerns, family relocation, alternative work schedules, and balancing work and family. The center participates in a number of institutional and national work/life initiatives and makes available information and research on these issues.

This year the center coordinated MIT's successful first-time application to the prestigious "100 Best Companies for Working Mothers" list sponsored by Working Mother magazine, collecting and summarizing work/life data from over 40 MIT offices and departments in the process. In addition, the Center participated in a regional work/life assessment, sponsored by the Boston College Center on Work and Family and the Boston Parents' Paper, which resulted in MIT's being named one of the Boston area's seven most "family friendly" employers.

The center also coordinated an initiative to create a major new web site highlighting the range of work/life resources offered by MIT departments and offices. The ground-breaking new site will provide an overview of MIT's work/life offerings and link to dozens of existing sites throughout the Institute. It is scheduled to be launched in spring 2001.

The center was also active in supporting a new MIT child care expansion initiative. Kathy Simons coordinated the committee that is planning the new child care center to be designed by Frank Gehry within the Ray and Maria Stata building. The Stata center will serve approximately 104 children and is expected to open in 2003. Kathy Simons also assisted the board of directors of MIT's Technology Children's Center with the recruitment and selection of its new Director, Marcy Lieberman and is working with the child care center on a renovation study for its Eastgate and Westgate facilities.

Rae Simpson, together with Professor Claude Canizares, was named Co-Chair of the Council on Family and Work. In preparation for restructuring the Council after four years of inactivity, the Co-Chairs engaged in a series of formal and informal planning meetings with members of the senior administration and constituencies throughout the Institute, drafted an action plan, and created two special task groups on job flexibility and on faculty issues.

The center responded to approximately 800 client inquiries and offered over thirty seminars and workshops on topics including adoption, job flexibility, child development, balancing work and family, multicultural family life, parenting, emergency/back-up child care, and schooling.

The two part-time co-administrators of the Center, Kathy Simons and Rae Simpson, will increase to full-time as of July 1, and Sandie Woo continues as full-time senior office assistant. The center has maintained 33% minority representation on its staff.

Kathy Simons, A. Rae Simpson

HUMAN RESOURCES INFORMATION SYSTEMS

Faculty Staff and Information Services (FASIS) reorganized to include the technical staff from the Benefits Office. It was renamed Human Resource Information Systems (HRIS). HRIS will continue to have the responsibility to acquire, maintain, and provide employment information about faculty, staff, and other persons affiliated with MIT and to ensure the currency, privacy, and accuracy of this information. With the addition of the Benefits technical staff, HRIS will be better positioned to provide high quality information services to the Human Resources Department and the MIT community.

Over the past several years there has been a significant effort to reduce duplication of effort within the Human Resources Department. The office continues to provide administrative support related to the Executive Committee Appointment Approvals, tenure tables, and faculty reappointments.

Development continued on the Salary Automation Review System for the administrative, faculty, senior researchers, sponsored research staff, and support staff reviews. Production for these reviews is scheduled to begin in the next fiscal year.

The new compensation system supporting the reclassification of administrative positions went into production this fiscal year. Under the direction of Steve Scarano, Assistant to the Vice President for Human Resources for Information Systems, HRIS provided the required in-house technical support for this effort. This included the assigning of new job codes and the conversion of all administrative staff records to the new code.

The preparation of approximately one million employment and benefit related documents were scanned into the Optix Electronic Image system by the beginning of this fiscal year. This has been a very successful project. Record information is now accessible by the desktop. It has eliminated the need for storage of paper files and allows multiple access to records.

A major effort was spent in planning technical support for the renovation and relocation of the Human Resource space. The move involved relocating the Benefits Office from the 4th floor to the 2nd floor space which was previously occupied by the Bursar's Office, the renovation of the main HR Department located on the 2nd floor, and moving the Implementation Resource Team from building N52 to E19, 2nd floor. We were able to move and setup all desktops, printers, and servers with minimal disruption. Also included in the planning of the move was converting from Novell to NT.

The Benefits system team continued their efforts to improve business process by streamlining transaction processing. Some of the results of their efforts include the ability to electronically collect dependent information for dental.

A major portion of the year was spent preparing for Y2K. I am pleased to report that all major systems were in operation on January 1, 2000. I would like to thank Kathleen Flynn and Clayton Ward for their good work on this project.

A new Institute initiative this fiscal year was the HR-Payroll Discovery project. This project was launched in July 1999. The scope of the project focused on MIT's high-level business requirements, technical capabilities of the SAP HR-Payroll module, and organizational and policy issues necessary to ensure successful system implementation.

HR-Payroll is an exciting and important initiative for MIT. The results of this effort will be services that make a real difference for our people and for the Institute. The integration of new business practices and new technology will support a broader scope of activities and focus emphasis on services to faculty, staff, and students.

Several of the HRIS staff participated on SAP HR/Payroll Discovery project. Kathleen Flynn has been appointed full-time to the SAP core team. This project will continue over the next eighteen months and will involve input and participation from the HR Department.

Other accomplishments included the following: the design and development of the HR Bulletin, which now serves as a communications tool for the Human Resources Department; working with members of the PSALM's team in an effort to move the generation of mailing labels from HRIS to Mail Services; and providing data for the 100 Best Companies for Working Mothers in collaboration with the Family Resource Center and Employment Services.

Toan Mac who provided technical support for the Benefits Office left the Institute after five years of service. Barbara Gilligan transferred to our department from Leadership for Manufacturing.

Claire Paulding

DISABILITIES SERVICES OFFICE

The Disabilities Services Office (DSO) is responsible for providing effective disability services and programs for students, faculty, employees, and visitors at MIT. These services include physical and communication access, academic accommodations for students, and the identification and implementation of reasonable accommodations for employees.

Over the past year, the DSO continued to work on Institute policies and procedures to provide accurate guidelines for students and faculty requesting/receiving services. These policies have unified the entities providing academic access at MIT by defining a more efficient and consistent system for obtaining services. Two important advancements in policy have been the revision of the Access and Accommodations for Employees and Students with Disabilities in the MIT Policies and Procedures Manual, and the Web Accessibility Policy. This policy ensures all Web pages associated with administration and services, courses of instruction, departmental programs, and institute sponsored activities, will conform to the Web accessibility principles guidelines set forth by the DSO, Adaptive Technology for Information and Computing (ATIC) Lab, and Information Systems.

The MIT Handbook for Students with Disabilities was published in December of 1999. This manual will continue to be used in training sessions with students, staff, and faculty. We have also worked with the Libraries and ATIC Lab in identifying appropriate technology for accessible workstations and state of the art informational access. The DSO continues to coordinate accessibility for students with disabilities by determining reasonable accommodations such as notetakers, scribes, extended timed exams, books on tape, sign language interpreters, and video taped classes. Our student response has been overwhelmingly positive as evidenced by an article about the DSO in the July-August issue of MIT's *Technology Review* magazine.

The DSO works with the personnel officers, departments heads, immediate supervisors, and outside agencies as well as conducts ongoing presentations to the MIT community on their responsibilities to: provide necessary accommodations during the hiring process; ensure that reasonable accommodations are identified when appropriate; and ensure that position descriptions do not impermissibly screen-out persons with disabilities.

Our goal for more accurate and timely responses to the needs of employees with disabilities and supervisors, remains a major focus for the DSO. To address this goal, we have formed DART (Disability and Assessment Review Team). This is a working group between the DSO and representatives from worker's compensation, benefits, long term disability, and ADA compliance at both the main and Lincoln campus. There are two goals for DART: one is to provide assistance to this group on handling complex disability cases; the other is to develop red flags within each process where it would be appropriate to bring in one of the other departments for consultation. Through this working group we have found that communication between our offices has greatly improved.

Barbara Roberts

RETIREMENT PROGRAMS ACTIVITY

The final phases of outsourcing Supplemental 401(k) Plan services to Fidelity Investments were completed. The expanded servicing capacity resulting from outsourcing made possible the introduction of new Supplemental 401(k) Plan features. Among the more popular of these new features were online access to account information and transactions, a loan provision, and flexible withdrawal options. The 401(k) Plan Oversight Committee assumed responsibility for oversight of investment of 401(k) Plan assets, and met regularly to review investment activity and performance.

The Benefits Office unveiled the first phase of an expanded retirement planning and investment education service. A menu of presentations, supplemented by individual consultations, was developed and offered to the MIT community. Total attendance at presentations was 4,029.

Plans to outsource the 401(k) Plan's retirement annuity purchase process were developed. These plans included the selection of commercial insurance companies to offer annuity products to future retirees and contract negotiations with these insurance companies.

The Benefits Office continued work with software vendor Lynchval Systems on the development and delivery of a pension calculation system to replace the current, obsolete PenCalc system. Delivery of the first release of the system is anticipated early July 2000.

Phil Lima

BENEFIT SERVICES

We introduced a long-term care insurance plan for eligible employees, retirees, and their spouses, parents, and grandparents. The objective of this plan is to offer the opportunity to purchase coverage that provides meaningful benefits for most long-term care expenses at group rates. We conducted 12 informational presentations on campus and at Lincoln Laboratory that were attended by over 350 people. The plan was well received with over 356 enrollments.

The Benefits Office, the Parking and Transportation Office and the Controller's Payroll Office worked together to implement a Qualified Transportation Fringe Benefit Plan to allow employees to pay for qualified parking on a pre-tax basis. The plan was announced to Parking Coordinators in August at a meeting hosted by the Parking and Transportation Office.

Following a study of income replacement under the Long-Term Disability (LTD) Plan, we announced an ad hoc cost-of-living adjustment for individuals whose benefit from that plan began prior to July 1993. This adjustment resulted in benefit increases between 7% and 75% and restored purchasing power to the group who has received this benefit over the longest period.

As part of our ongoing effort to streamline administrative procedures, we mapped, analyzed and modified several internal business practices.

There were several staff changes during the year. Marjory Magowan replaced Mary Markel as Supervisor of Benefits Services, while Mary assumed her new role as Human Resources Officer. Shawn Foley was promoted to Benefits Counselor, administering the Long Term Disability Plan. Marianna DiMarco assumed Shawn Foley's prior responsibilities as a Benefits Administrator. Ellen Cushman joined the staff as a Retirement Counselor. Roslyn Allen relocated to New York and was hired by the TIAA/CREF Institute.

Inasmuch as this was an exciting year, during which we made plans for the office relocation and welcome new staff members, it was also a very difficult year. Eda Barsoum went on disability leave.

We mourned the loss of our beloved friend and colleague, Andrea Surette, who died of ovarian cancer on July 26.

Marianne Howard

COMPENSATION

In the 1999-2000 fiscal year, the Compensation Office participated in 41 external salary surveys conducted by universities, associations, and consulting groups from across the country, and responded to over 100 email or phone requests for position-specific salary data. As in previous years, the Office conducted two major surveys with approximately 22 participants in each. These MIT survey results continue to provide us with a solid basis in determining our market position, and in developing our review allocation proposals to the MIT Corporation's Executive Committee. In addition to using our own surveys to determine market position for the Administrative and Support Staff, we incorporated several external salary surveys to assist us in preparing the allocation proposals.

Nine salary reviews covering approximately 6,158 Campus employees were conducted. Testing of a new web-based automated review system began this fiscal year, and was conducted during the Faculty, Sponsored Research, Support Staff and Administrative Staff reviews. Feedback from the testing departments was favorable, and we strive to have the web-based automated system ready for departments to use during the coming fiscal year's review cycle.

The Compensation Office continued the work begun in May 1998 to redesign the Classification and Compensation System for Administrative Staff. In February 2000 Administrative Staff were converted over to the new classification system that consists of six very broad-banded levels.

Managers were provided with informational packets along with individualized letters to inform their Administrative Staff about the details of the new system and their individual classification levels.

Compensation project teams worked with an outside vendor to build an online tool (the eValuation System). This tool simplifies and automates the job classification process and the writing of new Administrative job descriptions. The tool is still being refined and a formal permanent training program will be designed and implemented.

Approximately 55 administrative positions have been classified or re-classified since the February 2000 conversion this fiscal year (the total number of active classification positions that currently exist in the Institute's Administrative Staff Classification System is 800.)

During the year Nora Costa, Manager of Compensation, left the Institute.

Shirley Snyder Day, Judy Raymond

LABOR RELATIONS

The Office of Labor Relations is responsible for negotiating and administering the collective bargaining agreements covering approximately 1,300 MIT employees in five bargaining units. Labor Relations also represents MIT in grievance arbitrations and, in some cases, before administrative agencies in employment-related cases.

On July 28, 1999, the Institute signed a one year extension to the current agreement with the Service Employees International Union (SEIU), for the Campus Bargaining Unit. The extended agreement will expire June 30, 2001. On December 8, 1999, the Institute signed a one year extension to the current agreement with the Service Employees International Union (SEIU), for the Lincoln Laboratory Bargaining Unit. The extended agreement will expire June 30, 2001. On December 17, 1999, the Institute signed a two year agreement with the Research Development and Technical Employees Union. The agreement with the RDTEU will expire June 30, 2001. On March 14, 2000, the Institute signed a six year agreement with the MIT Campus Police Association (MITCPA). The agreement with the MITCPA will expire June 30, 2003. The wage increases in the agreements were consistent with MIT budgetary guidelines.

The number of grievances fell slightly from the previous year. Five arbitration cases were decided, with the arbitrator ruling in favor of the Institute in four of them. In another case, the Arbitrator issued an award confirming the Institute's position on the remedy in a prior case in which a split award (for the union on some issues and for the Institute on others) was issued. Six cases filed to arbitration were resolved and two withdrawn before the arbitration hearing. Four grievances have been filed to arbitration and have yet to be heard.

During the year, two cases were filed before the National Labor Relations Board. These cases were in addition to four cases that were pending before Board. All have been resolved.

In addition this Office provided advice and counsel to departments, centers and laboratories on issues that impact collective bargaining.

In June, Carol A Clark joined the Labor Relations section as an Administrative Assistant. Carol was previously an Administrative Assistant with the Department of Political Science. Carol replaces James Russell who left the Institute after fourteen years of service.

David B. Achenbach

EMPLOYMENT AND HUMAN RESOURCES SERVICES

The primary responsibility of the Employment and Human Resources Services section is to provide a full range of employee relations support to both employees and supervisors within the various organizational units. These include: staffing assistance, job counseling, policy interpretation, performance evaluation, salary administration and conflict resolution. This group consists of seven Human Resource Officers, one Employment Officer and three full time and one half time staff assistants.

This group also provides support in the processing of job listings, applicant materials, employment advertising and unemployment claims for campus employees. Services and Employment was also involved in the upgrading of the applicant tracking software, Web Hire.

We continue to partner with departments to improve MIT's presence on the web as an employer by listing job opportunities with careers.boston.com, the *Boston Globe's* on line job listing, and enabling prospective applicants to apply for MIT jobs on-line.

A number of staffing changes took place during this period of time. James H. McCarthy retired and Valerie Chu Stone terminated her employment with MIT. Wendy Williams and Susan Shannon, both newcomers to MIT, joined the group as Human Resource Officers. Also Mary Markel transferred from the benefits office to employment and services as a Human Resource Officer. Of the twelve people in the group, 90% are female and 20% are of a minority group.

A major initiative underway by the employment and services group is the development of a recruitment and diversity program, which will enhance the Institute's ability to attract and retain the best qualified applicants, which include minorities and women.

Kenneth Hewitt

IMPLEMENTATION RESOURCE TEAM

In April of 1999 recommendations from the Human Resource Practices Development Team for the implementation of an integrated system of competency-based human resource practices were approved by the Executive Vice President. The Implementation Resource Team was formed to begin this implementation process. The team became fully active in October of 1999. Members of the team included Barbara Peacock-Coady, Alyce Johnson, Mark Cason-Snow, Anastasia Frangos and Kimberly Nyce.

During the period October 1999 through June 2000 the team worked on the following projects:

- Initiation of pilots in two central administrative areas, the Controller's Accounting Office and Financial Systems Services.
- Creation and testing of tools to update job descriptions, develop competency models and use competencies for hiring in both of these pilot areas.
- Utilization of "lessons learned" from these two pilot areas to begin implementation of competency-based practices throughout the Human Resources Department and the Institute.
- Creation of competency-based tools which include an on-line system, "Comp Quick," designed to help hiring managers use the Administrative Core Competency Model for interviewing and hiring.
- Collaboration with several other MIT departments, labs and centers to educate and utilize competency-based practices for hiring.
- Creation of training courses for competency-based practices and career management.
- Evaluation of HRIS systems that support competency-based performance management and development systems. This included assessing pilot and community needs, developing protocols for evaluation, meeting with vendors and making recommendations.
- Development of an in-depth feasibility study on methods to deliver career services to MIT employees.
- Development of a business plan recommending a phased in approach for implementation of careers services for MIT employees.

Barbara Peacock Coady

PERFORMANCE CONSULTING AND TRAINING TEAM

The mission of the Performance Consulting and Training Team is to work with MIT and its departments, laboratories, centers, and offices to enhance their abilities to achieve business goals. Services include organization development, needs assessment, process improvement, team development, meeting facilitation, and custom-designed training.

In the spirit of this mission, PC&T was involved in a number of internal consulting projects throughout the year. Some clients include:

Executive Vice President's Office

- planning and facilitating the EVP retreats
- leading a group decision making process on a proposed structure for the HR-Payroll project

Committee for Undergraduate Programs

- planning and facilitating a retreat for committee members and others to set priorities for the year

New Faculty Orientation

- Designing and co-leading a session on managing graduate students in the labs

Working Group on Support Staff Issues

- serving as a resource to the co-conveners and task group leaders
- leading workshops on meetings practices and on building high-performing task groups

Central Accounting Office

- implementing competency-based human resource practices

Director for Environmental Programs and Risk Management/Senior Counsel

- integrating various departments for environmental and safety related matters
- developing an effective communication process

Human Resources

- planning and facilitating the leadership team's meetings

- facilitating the strategy for the Implementation Resource Team's rollout of competency-based HR practices
- serving as consultant about change management on the HR-Payroll project
- serving on the search committee for the new Vice President for HR

A special project this year was co-leading the development of a new rewards and recognition process; implementation is planned for next year. A second special project was implementing programs for MIT to increase its capacity for effective meetings, including meeting facilitation.

In addition to internal consulting, PC&T offered professional development courses for MIT employees. Approximately 1500 employees enrolled in over 50 different titles. New courses included Collaborative Leadership, Learning Styles Inventory, and Exercising Influence. This year, HR joined with Information Systems in publishing a joint catalog of courses to better serve MIT employees.

PC&T's Learning Environment Team operated the MIT Professional Learning Center (W89). LET surveyed customers to upgrade services. In partnership with IS, computers for training were updated. The demand for use of the various classrooms increased once again.

Margaret Ann Gray

FACULTY AND ACADEMIC STAFF COUNT

DEPARTMENT	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	*Subtotal - Tenure Track Faculty*	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	GRAND TOTAL	Instructor-G	Teaching Assistant	Research Assistant
PRESIDENT'S OFFICE																																
CHAIRMAN OF THE CORPORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
CHANCELLOR'S OFFICE	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
SECRETARY OF THE CORPORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**0**
PROVOST'S OFFICE																															
CENTER FOR ADVANCED EDUCATIONA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	0	0	7	0	0	0
DIBNER INSTITUTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	12	0	0	0	0	23	0	0	0
INSTITUTE PROFESSORS	0	12	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	21	0	0	0
OFFICE OF THE PROVOST	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	1	8	0	0	0
SUBTOTAL	**0**	**15**	**0**	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**11**	**0**	**0**	**0**	**0**	**0**	**19**	**1**	**2**	**0**	**11**	**60**	**0**	**0**	**0**
SCH OF ARCH & PLN																															
ARCHITECTURE, DEPARTMENT OF	2	9	6	7	3	27	3	0	0	0	0	2	9	0	1	0	1	0	4	5	5	2	0	5	0	0	0	11	75	0	96	22
CENTER FOR ADVANCED VISUAL STU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0
MEDIA ARTS AND SCIENCES SECTIO	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	128
MEDIA LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	2	0	4	0	1	12	0	0	0
PROGRAM IN MEDIA ARTS AND SCIE	2	2	5	1	8	18	0	0	2	0	2	1	1	0	0	0	0	0	2	4	3	1	0	3	0	0	0	0	37	0	0	0
SCHOOL OF ARCHITECTURE AND PLA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	2	0	0	0
URBAN STUDIES & PLANNING, DEPA	4	11	1	2	4	22	3	0	0	0	5	3	9	0	0	1	1	8	2	3	1	0	9	7	0	0	0	2	76	0	11	13
SUBTOTAL	**9**	**22**	**12**	**10**	**15**	**68**	**6**	**0**	**2**	**0**	**7**	**6**	**19**	**0**	**1**	**1**	**2**	**9**	**15**	**12**	**9**	**3**	**9**	**18**	**0**	**4**	**0**	**14**	**205**	**0**	**107**	**163**
SCH OF ENGINEERING																															
AERONAUTICS AND ASTRONAUTICS,	3	13	4	4	7	31	1	0	0	2	5	11	13	0	2	7	1	0	13	4	1	0	0	1	3	1	0	3	99	0	0	0
ARCHAEOLOGY, DEPARTMENT OF	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	6	140
ARTIFICIAL INTELLIGENCE LABORA	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	12	0	0	0	0	2	0	4	0	0	22	0	0	0
BIOTECHNOLOGY PROCESS ENGINEER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0	0	6	0	0	0
CENTER FOR INNOVATION IN PRODU	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	1	0	2	0	0	1	8	0	0	0
CENTER FOR TECHNOLOGY, POLICY,	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	3	0	0	0	0	4	1	0	0	0	12	0	0	0
CENTER FOR TRANSPORTATION STUD	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	7	0	0	0
CHEMICAL ENGINEERING, DEPARTME	4	16	5	2	3	30	0	0	0	0	1	4	2	0	0	32	11	0	18	0	0	0	0	3	0	7	0	5	113	0	19	141
CIVIL AND ENVIRONMENTAL ENGINE	6	15	4	7	6	38	0	1	0	1	4	0	8	0	0	8	4	0	7	0	0	0	0	2	3	3	0	3	82	0	31	141
DIVISION OF BIOENGINEERING & E	0	1	1	1	3	6	0	0	1	0	1	0	1	2	0	17	8	0	5	1	0	0	0	1	0	5	0	1	49	0	0	0
ELECTRICAL ENGINEERING & COMPU	13	62	5	14	12	106	3	0	1	1	9	14	6	1	4	2	0	0	3	2	2	1	0	0	0	5	0	0	160	0	117	498
ENGINEERING SYSTEMS DIVISION	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
INTEGRATED STUDIES PROGRAM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
LAB FOR ELECTROMAGNETIC & ELEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	0	7	0	0	0
LAB FOR MANUFACTURING & PRODUC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0
LABORATORY FOR COMPUTER SCIENC	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	9	3	0	10	0	0	0	0	3	3	11	0	0	41	0	0	0
LABORATORY FOR INFORMATION AND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	4	0	0	15	0	0	0
LEADERS FOR MANUFACTURING PROG	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
MATERIALS PROCESSING CENTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3	2	0	1	0	0	0	0	0	0	6	0	0	19	0	0	0
MATERIALS SCIENCE AND ENGINEER	4	19	5	0	5	33	0	1	0	0	5	4	7	0	4	18	2	0	8	2	1	0	2	2	0	9	0	2	100	0	12	117
MECHANICAL ENGINEERING, DEPART	5	30	3	8	8	54	2	0	1	0	17	8	27	0	3	22	1	0	2	1	0	2	0	2	4	10	0	0	156	0	27	273
MICROSYSTEMS TECHNOLOGY LABORA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	5	0	0	0	0	0	0	5	0	0	14	0	0	0
NUCLEAR ENGINEERING, DEPARTMEN	1	10	4	0	1	16	1	0	1	0	3	1	1	0	0	4	0	0	14	1	0	0	0	1	2	2	0	1	48	0	16	85
OCEAN ENGINEERING, DEPARTMENT	2	10	0	1	2	15	0	0	0	0	2	3	6	0	0	1	2	0	6	2	0	0	0	2	1	0	0	5	45	0	2	45
SCHOOL OF ENGINEERING	0	2	0	0	0	2	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	10
SYSTEM DESIGN AND MANAGEMENT P	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
TECHNOLOGY AND POLICY PROGRAM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	55
SUBTOTAL	**38**	**179**	**32**	**37**	**47**	**333**	**8**	**3**	**8**	**5**	**49**	**52**	**74**	**3**	**20**	**136**	**34**	**0**	**125**	**13**	**4**	**3**	**3**	**23**	**20**	**82**	**0**	**22**	**1020**	**0**	**238**	**1505**
SCH OF HUM & S S																															
ANTHROPOLOGY PROGRAM	1	3	0	1	1	6	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	15	0	0	0
CENTER FOR INTERNATIONAL STUDI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	8	0	0	0	0	20	0	0	0	1	36	0	0	0
ECONOMICS, DEPARTMENT OF	1	18	1	4	7	31	0	0	0	0	1	1	0	0	0	1	0	0	0	4	1	1	0	5	0	0	0	0	45	0	27	10
FOREIGN LANGUAGES & LITERATURE	1	4	1	2	1	9	0	0	0	0	0	3	20	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	36	0	0	0
HISTORY SECTION	2	4	3	2	2	13	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0
LINGUISTICS AND PHILOSOPHY, DE	1	8	3	4	4	20	0	0	0	0	1	0	1	0	0	2	0	0	1	0	0	0	0	24	0	1	0	0	50	0	10	16
LITERATURE SECTION	1	6	3	1	2	13	0	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0
MUSIC AND THEATER ARTS SECTION	2	5	1	1	3	12	0	0	0	0	0	6	10	0	3	0	0	0	0	0	0	0	0	1	0	0	0	7	39	0	0	0
POLITICAL SCIENCE, DEPARTMENT	1	9	3	3	7	23	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	28	0	17	35
PROGRAM IN SCIENCE, TECHNOLOGY	1	6	2	0	3	12	0	0	0	0	0	1	1	0	0	0	0	10	0	2	0	0	0	9	0	0	0	0	35	0	5	1
PROGRAM IN WRITING AND HUMANIS	1	5	1	1	2	10	1	0	0	0	0	1	18	0	11	0	0	0	2	0	0	0	0	2	0	0	0	0	45	0	0	0
SCHOOL OF HUMANITIES AND SOCIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	3	1
SUBTOTAL	**12**	**68**	**18**	**19**	**32**	**149**	**1**	**0**	**0**	**0**	**2**	**12**	**63**	**0**	**14**	**4**	**0**	**17**	**11**	**8**	**2**	**1**	**0**	**72**	**0**	**1**	**0**	**8**	**365**	**0**	**62**	**63**

DEPARTMENT	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	*Subtotal - Tenure Track Faculty*	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	TOTAL ACADEMIC STAFF	Instructor-G	Teaching Assistant	Research Assistant
SCH OF MANAGEMENT																																
ORGANIZATIONAL LEARNING CENTER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
SLOAN SCHOOL OF MANAGEMENT	4	50	4	3	26	87	0	0	2	0	4	18	1	0	0	2	0	0	1	4	3	3	4	19	0	0	0	2	150	0	113	49
SUBTOTAL	4	50	4	3	26	87	0	0	2	0	4	19	1	0	0	2	0	0	1	4	3	3	4	19	0	0	0	2	151	0	113	49
SCH OF SCIENCE																																
BIOLOGY, DEPARTMENT OF	4	29	4	5	8	50	0	0	0	0	9	1	0	0	6	48	48	1	54	0	0	0	0	7	0	12	0	6	242	0	0	98
BRAIN AND COGNITIVE SCIENCES,	1	12	2	2	5	22	0	0	1	0	3	0	3	0	2	17	21	0	18	1	1	0	3	3	0	4	0	0	99	0	9	2
CENTER FOR CANCER RESEARCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	12	1	35	0	0	0	0	1	0	4	0	3	87	0	0	0
CENTER FOR LEARNING AND MEMORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	1	9	0	0	0
CENTER FOR SPACE RESEARCH	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	13	4	0	4	0	0	0	0	0	0	1	0	0	24	0	0	0
CHEMISTRY, DEPARTMENT OF	3	18	0	2	6	29	0	0	0	0	5	0	1	0	0	47	43	0	7	0	1	0	0	2	0	6	0	2	143	0	54	133
EARTH, ATMOSPHERIC, & PLANETAR	1	30	1	3	1	36	0	0	1	0	3	1	0	1	0	25	13	1	12	3	1	2	0	0	0	12	0	2	113	0	18	71
EXPERIMENTAL STUDY GROUP	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0
LABORATORY FOR NUCLEAR SCIENCE	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	8	1	0	16	0	0	0	0	0	0	24	0	11	63	0	0	0
MATHEMATICS, DEPARTMENT OF	1	32	3	2	13	51	0	0	0	0	0	0	5	22	0	2	7	0	10	2	0	0	0	16	0	1	0	0	116	0	59	11
PHYSICS, DEPARTMENT OF	7	42	6	3	11	69	0	0	6	0	17	2	0	0	5	9	5	0	1	2	0	0	0	0	0	15	0	9	140	0	35	175
SCHOOL OF SCIENCE	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
SPECTROSCOPY LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	29	0	0	33	0	0	0
SUBTOTAL	17	164	16	17	44	258	0	0	13	0	37	5	13	23	13	210	156	3	157	8	3	2	3	29	0	108	0	36	1077	0	175	490
TREASURER'S OFFICE																																
TREASURER'S OFFICE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
VP - HUMAN RESOURCES																																
MEDICAL DEPARTMENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	151	151	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	153	153	0	0	0
VP & DEAN - RSCH																																
CENTER FOR ENVIRONMENTAL HEALT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5	0	0	7	0	0	0
CENTER FOR MATERIALS SCIENCE A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	1	0	0	5	0	0	0
CLINICAL RESEARCH CENTER	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	10	0	20	0	0	0	0	0	0	36	0	3	70	0	0	0
DIVISION OF COMPARATIVE MEDICI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	1	2	0	0	0	0	0	0	12	0	5	28	0	0	0
DIVISION OF TOXICOLOGY	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	15
ENERGY LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	3	6	5	0	0	19	0	0	0
FRANCIS BITTER MAGNET LABORATO	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	6	3	0	0	0	0	0	0	1	0	17	0	0	28	0	0	0
GRADUATE EDUCATION OFFICE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
HAYSTACK OBSERVATORY	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	6	0	0	0
HRVD-MIT DIVISION OF HEALTH SC	1	4	1	0	0	6	0	0	2	0	1	1	4	0	0	11	12	2	25	3	0	0	0	18	0	12	0	85	182	0	2	77
NUCLEAR REACTOR LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	7	0	1	13	0	0	0
OPERATIONS RESEARCH CENTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	37
PLASMA SCIENCE AND FUSION CENT	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	6	0	0	19	0	0	0	0	3	0	27	0	0	61	0	0	0
RESEARCH LABORATORY OF ELECTRO	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	17	3	0	62	0	0	0	0	0	0	23	0	0	106	0	0	0
SEA GRANT COLLEGE PROGRAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	4	0	0	0
TECHNOLOGY AND DEVELOPMENT PRO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0
SUBTOTAL	2	4	1	0	0	7	0	0	10	0	2	2	4	0	0	51	34	3	142	3	0	0	0	26	7	146	0	95	532	0	11	131
VP - RESOURCE DEV																																
OFFICE OF THE VICE PRESIDENT O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
DEAN-UNDERGRAD EDUC																																
AIR FORCE AEROSPACE STUDIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0
ATHLETIC DEPARTMENT	0	0	5	4	5	14	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	19	1	42	0	0	0
CAMPUS ACTIVITIES COMPLEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
MILITARY SCIENCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	1	2	8	0	0	0
NAVAL SCIENCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	9	0	0	0
OFFICE OF THE DEAN OF STUDENTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
SUBTOTAL	0	0	5	4	5	14	0	0	0	0	0	0	0	8	20	0	0	0	0	3	0	0	0	0	0	0	20	4	69	0	0	0
ADMINISTRATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0
GRAND TOTAL	82	502	88	90	169	931	15	3	35	5	102	96	174	34	68	405	237	32	451	51	21	12	19	206	28	343	20	355	3643	0	706	2401

*Other Academic Staff includes: Institute Professors Emeriti, Honorary Lecturers, Affiliated Artists, Postdoctoral Trainees, Visiting Senior Lecturers, Visiting Instructors.

VICE PRESIDENT FOR INFORMATION SYSTEMS

Information Systems (IS) supports MIT's core missions of education, research, and service by working in partnership with its faculty, students, and staff to wisely and creatively apply information technology to reach their goals. IS strives to be MIT's information technology services partner of choice, delivering quality products, support, and services that are customer-focused and add value to the MIT community. To achieve this vision, IS people must be leaders and technical innovators, continuously gauging their work against customer needs, expectations, and wants, as well as higher education and industry trends. IS's ultimate success, and therefore the success of its people, is dependent upon customer satisfaction.

During fiscal 2000, IS staff achieved an impressive range of accomplishments, some of which are highlighted in the reports which follow. Throughout IS, we organize our work around three explicit elements: IS's customers, its work, and the skills of its staff. The environment that we are building for IS is functional, attractive, and meets staff needs.

Leaders of I/T Practices advocate both on behalf of customers to IS, and on behalf of IS to customers. The Practice directors promote and enable technology-based work at MIT. They assist the Institute community in identifying information technology needs, as well as opportunities to use technology in education, research, and administration. The Practices also assist in planning for the effective use of I/T resources. To support academic computing, IS was deeply involved this past year in supporting the work of the Council on Educational Technology (CET), working with MIT faculty and staff on student-owning computing, wireless, educational portals, lifelong learning, and alumni involvement initiatives. To support administrative computing, IS continued to promote standards and hardware and software renewal. To support voice, data, and image networking, IS was involved in Internet2 efforts. IS also presented and received approval for new communications rates. Additionally, IS outlined a plan for renewing the MIT communications infrastructure and making the improvements necessary to support the next generation of research and teaching at MIT. Key work is underway in all the plan's phases.

As a process-centered organization, the work of developing and operating I/T products and services is the responsibility of five I/T Processes—Discovery, Delivery, Service, Support, and Integration. Highlights of our work include the delivery of an important set of web-based applications, the operation of a growing set of services and servers, and support of a larger, more sophisticated community of I/T customers. Use of MIT's I/T resources continues to grow as the I/T infrastructure is improved and expanded. IS continued to maintain MIT's I/T environment at a high level of availability. During 1999–2000, the MIT community came to IS with some 100,000 requests for help and service changes, ranging from upgrading telephone service to installing a new office computing environment to assisting faculty in using computers in their teaching. Accomplishments of particular note were the establishment of the I/T Architecture Group and the fact that, despite fears about the Year 2000, all systems continued to work well, and we have a significantly better understanding of MIT's entire I/T environment as a result of our careful preparation.

The I/T Competency Group concentrates on the skills dimension of Information Systems, working to provide a staff well-qualified to meet future work requirements. Of particular note is IS's continuing work to ensure staff retention by addressing market salary parity issues and offering a growing selection of workshops that inform and develop staff.

IS spent considerable time and energy over the past year working on its Strategic Plan that is used intentionally to guide our work; on measuring our work; and on pursuing change initiatives. IS's Strategic Plan will be published in its final form on the Web and on paper this fall. The Strategic Themes guiding our work are:

- Theme 1: Engage customer to realize value from information technology (I/T)
- Theme 2: Deliver new I/T products, support, and services
- Theme 3: Operate and improve MIT's I/T environment
- Theme 4: Foster individual and organizational development

More information about Information Systems and its work—including information about its affirmative action progress and plans—may be found on the World Wide Web at http://web.mit.edu/is/.

James D. Bruce

ACADEMIC COMPUTING PRACTICE

The Academic Computing Practice (ACP) provides a robust infrastructure to support MIT's educational computing needs. In its work, it plans and supports new academic initiatives; responds to new developments in technology, media, and educational practice; and creates new organizational arrangements to better serve its clients. The ACP was a key participant in the efforts to frame a coherent agenda for educational technology at MIT and its application to address the changing environment of university education.

New activities in ACP in FY2000 focused on planning for new initiatives in educational technology. It collaborated with the Center for Advanced Educational Services (CAES) to launch the Education Media Creation Center (EMCC) and with the MIT Libraries to implement Spatial Data Services for the campus, as well as in the Digital Shelf Space (DSpace) initiative to address storage needs for digital materials. Staff from Information Systems worked with the MIT Council on Educational Technology through its subgroups, particularly on strategic and infrastructure initiatives. Among these initiatives were a wireless network for the Institute, development of re-configurable classrooms, and an investigation of an educational computing environment where each student has a laptop computer. This last initiative is expected to lead to an academic computing environment that supports mobility, that is multi-platform, and where Athena clusters are transformed, over time, into multi-functional teaching and learning spaces and special-purpose clusters. Implementation of this model will lead to an infrastructure that supports student-owned computers more intentionally and extensively than at present.

During fiscal year 2000, the Academic Computing Practice continued its annual efforts to renew the Athena Computing Environment purchasing some 200 workstations for public and departmental clusters to replace machines at the end of their useful lives. As part of this work, ACP initiated several investigations of Linux and has developed a "layered" Linux Athena release that provides key Athena functionality to the Linux platform. ACP also chartered a Discovery effort to examine the place of SGI workstations in the Athena environment. As a result of this study, ACP announced that SGI machines would be eliminated from Athena in 2003. Staff will work with faculty who are now dependent on this platform to identify alternatives.

Work also continued on Project Pismere to build a scalable, centrally-managed Windows 2000 environment that works within the MIT computing infrastructure, so that both clients (desktops) and servers can interoperate with all MIT services, including those provided by the Athena computing environment. A Fall 2000 Pismere deployment in the Department of Urban Studies and Planning is planned.

The Academic Computing Practice was also active in supporting the development and delivery of academic subjects. Among these were work in 6.003 *Signals and Systems*; in *Berliner Sehn*, a hypermedia documentary for German Studies; in an experimental performing arts collaboration with New York University delivered using Internet2; in PIVOT (Physics Interactive Video Tutorial); and in the use of streaming video.
In the coming year, the Academic Computing Practice will expand its role in influencing and directing information technology resources by extending its partnership with the Deans of Undergraduate Education and Residential Life. It will also continue to work closely with the MIT Council on Educational Technology and with faculty in the schools and staff in the Libraries and other areas to develop effective support for new educational technology initiatives.

M. S. Vijay Kumar

OFFICE COMPUTING PRACTICE

The Office Computing Practice seeks to maximize the value that administrative computing customers obtain from MIT's information technology (I/T) resources. To assist MIT in achieving its mission, the Office Computing Practice uses partnerships with administrative departments and collaborations with I/T teams to build constructive relationships with organizational units. The work of this Practice relies on a current understanding of office computing needs, business processes, opportunities, and priorities, as well as the accurate and efficient anticipation of its customers' future needs.

In keeping with its core mission, the Office Computing Practice promotes standards for hardware and software platforms. These standards are predicated on the interoperability of applications with MIT's I/T infrastructure. In today's I/T marketplace, it is a formidable challenge to find the right balance between personal and institutional value while meeting the security and reliability requirements of a world-class university.

The Office Computing Practice actively assists departments as they evolve their use of I/T by replacing their hardware and software components. In fiscal year 2000, the Practice continued to sponsor MIT-wide efforts to

identify needs, and to upgrade older desktop computing environments. As the year closed, a formal program to renew the administrative computing environment was instituted. The overall goal of this program is to ensure that administrative desktops always have current versions of software, and that one-third of all administrative desktops are renewed every year.

In response to expressed customer needs, the Office Computing Practice led efforts to charter a Software Release Team. This team focuses on recommending the desktop software that IS will support, as well as communicating information about the life cycle of supported products. With the IT-Partners Group's endorsement, the Practice ceased supporting Windows 95 and Eudora v 2.2. This team will continue to focus on current software versions, improved reliability, compatibility, and support in the coming year.

The Office Computing Practice continued its work to shape the vision and direction of information technology at MIT by participating in the development of the Information Systems Strategic Plan. As result of this planning effort, the Practice continued strengthening its partnerships. During spring 2000, the Practice planned and coordinated a Microsoft Executive Visit, which included key I/T staff from across the Institute, as well as IS staff. The key goal of this visit was to learn about Microsoft's current and future directions, while strengthening MIT's relationship with them through education about the challenges facing a research university now and in the future.

The Office Computing Practice co-championed a "Year 2000" Delivery team to ensure an uneventful start to the millennium at MIT. To generate awareness and action, the team initially focused on explaining the Y2K problem and educating the MIT community via seminars, Web pages, and other written communications. During the last quarter of 1999, the team turned to risk assessment and contingency planning. The careful preparation by this team, Facilities, and other Institute organization, as well as external suppliers, ensured that the transition from 1999 to 2000 was, in the words of President Charles M. Vest, "a boring evening, just like we hoped."

The Office Computing Practice performs its work through active partnerships. Partnerships between customers and providers of I/T are essential in the rapidly changing world of information technology. Continued support of the IT Partners group, the Business Liaison Team, the MIT Professional Learning Center, and the myriad I/T teams and users throughout the Institute fosters a collaborative, productive environment.

Theresa M. Regan

VOICE, DATA, AND IMAGE NETWORKING PRACTICE

The mission of the Voice, Data, and Image Networking Practice (VDIN) is to ensure that the necessary information technology (I/T) systems and services are available to support the communications needs of MIT's academic, research, and administrative efforts. This includes working with IS Process owners and outside vendors to ensure that current systems are accessible and have adequate capacity. In addition, this Practice helps identify new communications technologies and facilitates their availability to meet future needs.

During 1999–2000, Information Systems (IS) accomplished the following:

Last year, the VDIN Practice chartered the VDIN Rate Review Project Team to recommend a new rate structure for IS's voice, data, and network services. The team completed its work, and its recommendations and a set of proposed rates were presented to the Budget and Finance Steering Group (B&FSG), which approved a plan to phase in new rates by fiscal 2004. Initially, IS will be simplifying and lowering the rates charged for direct-dialed telephone calls from the campus. This change is expected to reduce the charges to Institute departments, laboratories, and centers by $500,000 per year and is the result of renegotiations of contracts and the transition to more competitive vendors. Other rate changes will occur in later years. In addition to revising rates, IS will also revamp its internal cost accounting structure to allow for more frequent and more accurate analysis of rate-based revenue and related expenses.

IS also presented a proposal to replace MIT's Lucent 5ESS telephone system to the B&FSG; this proposal will go to the Institute's Executive Committee this fall. This project is estimated to cost $9.1 million and is expected to be completed by December 2001.

IS continued to upgrade much of MITnet's intrabuilding equipment this year, providing 100 mbps network service in buildings where adequate wiring exists. In addition, several projects to build new closets and upgrade wiring are underway. Over the coming years, IS will continue to renew its facilities so that 100 mbps desktop service becomes standard.

The VDIN Practice also sponsored several other projects looking into extending MITnet capabilities to support new academic initiatives. A team examined the possibility of providing higher speed connectivity to off-campus residences using Digital Subscriber Line (DSL) and Cable Modem technology. Another group looked into adding Wireless LAN capability to MITnet. This latter group's work resulted in a decision to provide wireless access in classroom, library, and other areas where students congregate, an effort which is estimated to cost $1.45M over four years.

MIT–IS continues to be an instrumental member of the Northern Crossroads (NoX) consortium. The NoX gigaPOP was opened this year in Boston. This facility will provide an interconnection point for Internet2 universities in the New England area with access to Abilene and other networks. Technical operations are being handled by Harvard University, and financial management being done at handled by MIT. MIT's Internet2 connectivity is still being provided via the vBNS network until our connection to the NoX is completed next year.

Dennis Baron

I/T DISCOVERY PROCESS

The core mission of the I/T Discovery Process is to ensure that customers realize up-front value from information technology (I/T) through business analysis, best practice research, data model and conceptual design, and strong sponsorship supporting change. Discovery projects yield firmly sponsored commitments and an accelerated path for work through the subsequent I/T work processes: Delivery, Integration, Service, and Support. As an established method for linking I/T to business strategies and customer needs, Discovery teams seek to reinforce the shared nature of I/T work across the Institute. A highlight of Discovery work this year was to integrate change and policy issues into enterprise-wide projects.

Key projects in fiscal year 2000 supported the goals of the Themes 1 and 2 of IS's Strategic Plan:

In keeping with its strategic goal to maximize value through enterprise-wide initiatives, Discovery led the effort to implement the SAP HR-Payroll module at MIT. A highlight of this project was the Discovery team's working closely with Administrative Systems and Policies Coordinating Committee (ASPCC) on business change and policy issues.

In support of MIT's academic mission, Discovery teams worked on issues related to Student-Owned Computing and Lifelong Learning, two key initiatives sponsored by the MIT Council on Educational Technology (MITCET). In addition, Discovery worked as a resource for Alumni Engagement, another MITCET initiative.

Working with the Academic Computing Practice, Discovery completed work resulting in creation of the Linux-based Athena environment for MIT, investigation of a centrally supported Spatial Data service, investigation into provision of a service to provide extended computing job services via Athena, initiated work to redesign the Athena interface, and reached a decision to diminish our use of the Silicon Graphics workstation in the Athena environment. In support of MIT web initiatives, Discovery teams worked with students to determine Web portal services. Discovery teams also worked closely with the MIT Libraries on electronic reserves, electronic theses, and the initial stages of a project for a new integrated library system.

Working with the Office Computing Practice, Discovery projects recommended that IS support the Internet Message Access Protocol (IMAP) to improve email services at MIT. In addition, Discovery teams made recommendations for on-line credit card processing, implemented a new system for MIT Parking, and began work on an MIT Access Card project. The Discovery effort to improve our ability to broadcast information widely to the Institute community resulted in improved, web-based access to mailing list management services.

In the Voice, Data, and Image Networking Practice area, Discovery teams recommended an Enhanced Voice Directory Service to MIT to improve and extend telephone directory services. At the end of the year, a Discovery team was formed to explore options to provide high-speed residential networking services to the MIT community.

Discovery assisted the IS strategic planning effort by recommending a new service—"Plan Alive," a tool which is currently being developed by a Delivery team—to keep the strategic plan vibrant and current.

In July, Discovery recognized its fifth anniversary with a celebration of accomplishments, growth, and Institute-wide involvement.

Greg Anderson

I/T DELIVERY PROCESS

As the second of the five work processes, the I/T Delivery Process exists so that MIT and its schools, departments, laboratories, and centers can realize business value as rapidly as possible from the implementation of new information technology products and services. Delivery work is organized exclusively into projects. Each Delivery project typically is launched after a Discovery project has qualified the business case and determined a technical approach. Currently there are fifteen active Delivery projects (all supporting Theme 2 initiatives); fourteen others were successfully completed in all of fiscal 2000. Both figures represent slight improvements over fiscal 1999.

In the past few years, MIT has put in place the major structures of an enterprise application architecture that will last many years. Several new client-server transactional systems (SAP, COEUS, NIMBUS, Adonis, etc) are now in place. All draw "master data" reference files from the MIT Data Warehouse, where they in turn send their transactions nightly. The Warehouse also reduces reporting demands within each of the feeder transactional systems, since its data structures are optimized for reporting and it has excellent end user tools. Use of the MIT-developed "Roles" database as the main source of user authorization information has continued to expand. Recommendations have been implemented to take the next steps in this "Roles" evolution, further simplifying and standardizing the authorization process.

Significant Delivery effort continued to be expended in enhancing SAP, including the upgrade to version 4.5. Following the successful rollout of ECAT2, a second generation, web-based electronic catalog system fully integrated with SAP, the older ECAT1 system was retired. Thanks to ECAT2 and other e-commerce initiatives, the use of paper requisitions now accounts for less than 30 per cent of purchasing activity at MIT. The MIT-developed COEUS proposal management system was upgraded with two releases, 3.1 and 3.5, during the past year. Also, the Budget Office completed deployment of the new NIMBUS budget submission system. Finally, the MIT Events Calendar system, an extension of a service previously run by *The Tech*, was made available to the entire MIT community in May, when it was featured on the MIT home page.

This past year saw greater investment and activity in academic work. The Athena environment was extended to new, inexpensive PC platforms with the success of the Linux Athena pilot. Further extensions to Athena were demonstrated by the development of "Layered Athena" software for selected customers of private Athena workstations. Further efforts are underway to make standard Athena simpler to install and maintain for administered systems in Departments, Laboratories, and Centers. Most of the Delivery work in the Pismere project has been completed. Pismere's purpose is to permit the porting of almost all Athena functionality to Microsoft's Windows 2000 operating system. As part of a larger collaboration effort with the MIT Libraries, projects in Electronic Reserves, Desktop Delivery of Thesis reprints, and Electronic Thesis Submission all reached important milestones. In the coming year, we also anticipate involvement with the Libraries in their collaborative project with Hewlett Packard called DSPACE (http://web.mit.edu/dspace), and in the installation of a new business system to replace the older GEAC Advance system.

There are a number of efforts initiated this year in the Delivery area that will not result in obvious changes for the vast majority of end users, but instead are aimed at strengthening the support infrastructure. These include the Enterprise Printing Project, the Enterprise Backup Project, and the Casetracker Project. More information can be found at http://web.mit.edu/is/delivery/.

Overall, this coming year should see maintenance of the recent gains on the administrative areas, with major new collaborative and development activity occurring with the Libraries, with the Alumni Association, and around the MIT Council on Educational Technology initiatives.

Robert V. Ferrara

I/T SERVICE PROCESS

The core mission of the I/T Service Process is to manage MIT's information technology infrastructure reliably and efficiently. During the past year, I/T Service teams from areas including the Data Center in W91, MITnet, telephone and related services, the Athena Computing Environment, database services, and desktop maintenance (PC repair) reached significant milestones in support of Theme 3 initiatives.

A major effort for all groups within Service was to prepare for the Year 2000 (Y2K). All systems were checked, upgraded if necessary, and then tested. IS's major accomplishment was that Y2K was a non-event thanks to a lot of hard work by teams in I/T Service, such as the Business Continuity Management Team's Y2K Transition Team, the Network Security Team, teams in the ODSUE and Residential Life, SIPB, and Facilities, as well as the continued strong support of Academic Council and MIT senior management.

The past year has been both challenging and exciting in the Data Center. Data storage tripled this year to a total of approximately seven terabytes, the largest storage growth associated with SAP. The number of administrative servers doubled again in fiscal 2000 to 200, including a complete renewal for the SAP environments. Many business units added front-end Web servers to their existing application servers. The average availability per system reached an all-time high of 99.97%. To address the significant growth in storage and servers, Storage Area Networks (SAN) and Enterprise Storage were implemented. Additionally, a new automated backup solution was purchased and will be implemented in fiscal 2001. These major changes in the computing architecture will help address the business needs for greater system availability, performance, and reliability.

A major initiative in the Telecommunications area was a renewal process for the 5ESS telephone switch as it has reached the end of its 10-year life expectancy. We expect approval of this purchase in September and installation by the end of 2001.

The MIT Security Team is a combination of IS staff, student employees, and volunteers from the Laboratory for Computer Science (LCS), the AI Lab, the Media Lab, LIDS, and the Whitehead Institute. During the last quarter of fiscal 2000, the team handled an average of 37 new cases a week, the majority of which were problems discovered during routine vulnerability scans. For its second year, the team is hosting a daylong meeting focused on sharing information, techniques, and ideas among security teams at area colleges and universities. Web pages related to last year's event are at http://mit.edu/net-security/Camp/.

Over the past year Athena Cluster Services and PC Service were effectively merged into a single team and have adopted the team name of Hardware Services. A new service that has been successful is the Disaster Recovery and Assessment Service. Here, Hardware Services assists departments in assessing damage to computer systems caused by floods, power surges, etc. We have been able to quickly assess computer systems and peripherals, get many systems back into service and expedite replacement, working with the Office of Insurance and Legal Affairs. As in previous years the team continues to provide system deployment services and Repair and Maintenance for both Academic and Office Computing Practices, along with other department owned systems and printers.

The Database Services Team worked with the Institute's major administrative departments to maintain 90 databases supporting SAP, Admissions, Alumni, Payroll, Pension, Personnel, and IS-Telecommunications, among others.

Roger A. Roach

I/T SUPPORT PROCESS

The core mission of the I/T Support Process is the effective and efficient delivery of high-quality support services to the Institute's information technology users. Support is provided by a variety of standing teams: I/T Help Desk; Business Liaison Team (BLT); the MIT Computer Connection (MCC); Training and Publications; Software Release Team; Adaptive Technology Support (ATIC Lab); Departmental Computing Support (DCS); Web Communications Services (WCS, formerly CWIS); Athena Help/Residential Computing Consulting; Academic Computing Support; 5ESS Support; Stopit; and Support Team Headquarters. Non-standing teams, such as the Usability Group, also provide key elements of support. Customer support is provided via e-mail and the Web, by telephone, at the customer site (including dormitories and FSILGs), or through walk-in service in several locations.

To better identify and refine support services, Support team members work to improve the help process by listening carefully to customers and balancing customer feedback with Institute goals and resource availability. While focused on different aspects of users' needs, the highly qualified staff on these teams share a common commitment to the I/T Support mission. During 1999–2000, the Support Process focused on Theme 1 of the IS Strategic Plan: engage customers to realize value from I/T through ongoing dialogue about their academic, research, and business computing needs and improve responsiveness, availability, and expertise of I/T staff while controlling costs.

In response to customer feedback, four key initiatives were identified as part of Theme 1 of the IS Strategic Plan. Work related to these initiatives commenced in the current year and will continue during 2000–2001. The initiatives are:

- Improve the help process.
- Improve communications regarding IS products, services, and support.
- Increase customer engagement in the discovery, delivery, and integration processes for the Institute's enterprise applications strategies.
- Engage fully in MITCET (Council on Educational Technology) discussions and other Institute efforts to plan the future of academic computing.

Some specific activities during 1999–2000 that contributed to the goals of these initiatives include:

- Rollout of a revised version of Casetracker, IS's customer assistance and problem resolution tracking tool.
- Refinement of the customer support process for SAP, ECAT, and other enterprise applications.
- Delivery of software and hardware training to over two thousand administrative and support staff to help improve business productivity.
- Strengthening of the strategic relationship between Web Communications Services and the Publishing Services Bureau.
- Implementation of an Extended Voice Directory Service to improve telephone directory services during peak times and unstaffed hours.
- More intentional dialogue with customers about their computing and networking needs, including completion of multiple customer surveys, expanding and strengthening the IT Partners program, and formation of a Desktop Support Customer Advisory Group.

William F. Hogue

I/T INTEGRATION PROCESS

The mission of I/T Integration is to implement an information technology infrastructure that has high levels of reliability, availability, and serviceability; provides excellent price/performance; meets current MIT needs and can quickly adapt to meet future needs; and enables the effective performance of the other I/T processes. This year, as in previous years, Integration teams concentrated on helping development teams use MIT's current I/T infrastructure. Educational and consulting efforts continue to be the most important work of Integration. During the past year, teams working in the Integration Process made progress on several fronts, usually in support of Theme 3 strategic goals.

The I/T architecture tasks of the Integration Process moved to a new MIT-wide group chartered by the Provost and the Executive Vice-President, including representatives from MIT Libraries, Sloan School of Management, Lab for Nuclear Science, Financial System Services, Student Services I/T, the Provost's Office, and Office of Sponsored Programs, as well as Information Systems Integration staff. This group determines the I/T architecture, standards, and guidelines; reviews I/T projects for fit within the current standards and guidelines; and communicates their directions while gathering feedback from the community.

Educational efforts continued for software designers, developers, and integrators about MIT's current I/T infrastructure and new directions. The monthly seminar series drew 50–80 MIT developers per session continued, covering such topics as: Kerberos for Macintosh; The Network Security Team; Wireless Networking; Oracle Web Development; Web Server Programming Using Java Servelets; Controlling Read and Write Access to Oracle Database Tables, Columns, and Rows; Formula One for Java, an Enterprise Java Bean; Web Database Design for Dummies, and The Data Administration Function at MIT. This year, the Integration process extended the exchange of information to a new forum including the Institute's business leaders.

Integration staff also acted as consultants for MIT designers and developers, as well as outside vendors selling systems to MIT. Discussions with vendors to explain technology paid off with the addition of certificate technology in a SAP web product and in positive responses from Library management vendors. The Integration Team also worked with commercial vendors to ensure that products incorporating Kerberos would interoperate, and they helped organizations outside MIT learn about and use Kerberos. With IS's help, Microsoft added Kerberos to Windows 2000. Apple also agreed to ship Kerberos with Max OS X. These two vendors join SAP and Oracle as major vendors supporting Kerberos.

Integration project teams worked both to update current I/T infrastructure and to add appropriate new infrastructure. Key among these were efforts are new desktop versions of Kerberos for the Macintosh and PC with better user interfaces, the addition of triple DES to Kerberos to increase security, the extension of Athena authorizations for class lists, the addition of a new interface to our mail servers to better handle stored e-mail and newer e-mail clients, helping with the design and implementation of an e-mail notification system for SAP events such as requisition approval, building a component used first by Personnel to facilitate secure database connections from a Java applet, and purchase of a Java component for spread sheets.

The "I/T watch" subprocess is designed to track technology directions. During fiscal 2000, Information Systems staff tracked changes in such technologies as Java, web development tools, web servers, object-oriented technology, Corba developments, modeling tools, in addition to the vendor software products that we have already deployed at MIT.

Susan S. Minai-Azary

I/T COMPETENCY GROUP

The I/T Competency Group (CG) is responsible for ensuring that IS has the right people in the right jobs, with the right technical and behavioral competencies, at the right time. This is the key work outlined in Theme 4 of the IS Strategic Plan. In order to achieve this mission, CG is involved in processes and programs focused on recruiting, retaining, retraining, and restructuring staff. In addition, CG continues to work closely with MIT's Human Resources department, and acts as an internal focal point for IS employee relations.

After several years of work to address market pay parity issues—the most common reason cited for voluntary staff departures—IS's attrition rate dropped to 8% in fiscal year 1999. Unfortunately, with the tight market for qualified I/T staff, attrition rose is fiscal year 2000 to 16%.

Since retention involves more than pay, CG also continued to conduct staff opinion surveys and exit interviews to understand why people stay in IS and why they leave. Based on these interviews, CG worked to address other areas, including quality of leadership, quality of worklife, and sense of organizational focus.

CG participated in the MIT Classification and Compensation Project's Advisory Team and rolled out the new Administrative job classification to IS staff. The new classification was generally well received. CG is in the process of defining IS jobs using the new system. In addition, CG is providing input to other I/T job definition efforts to help ensure consistency across MIT.

CG continued to sponsor or participate in a number of activities designed to inform and/or develop competencies in IS. The CG web pages were enriched with a development resource guide and a recommended reading list, both linked to the list of IS competencies. In addition, CG worked with the Performance Consulting and Training Team (PC&T), to pilot a program on 'Exercising Influence,' which ties to the MIT Compensable Factor of 'Influencing and Leading.' The pilot program was considered very successful, and PC&T plans to offer it again.

CG continued to promote competency-based interviewing and to provide assistance to other MIT departments seeking assistance with recruiting, including the MIT Police Department, PC&T, and the central Human Resources (HR) organization. HR continued to use the web "wrap" program, which posts all MIT jobs on the *boston.com* web pages. (CG introduced this to HR last year; it is an increasingly robust source of candidates.) CG sponsored a new web recruiting service for I/T skills (*techies.com*) which was made available to MIT departments. To increase the effectiveness of the recruiting process, CG hired a part-time contract recruiter. This has helped significantly in reducing the cycle time to fill positions, as well as increasing the number of qualified candidates hiring managers can consider. CG is also a participant in the central HR 'Recruiting and Diversity' Initiative.

Working with an external consultant, CG continued to work on team development and team leader development. This included several interventions with teams: coaching team leaders and facilitating team meetings. Attention was also focused on performance management. The new classification model, including the eValuation tool, has been used to set and clarify expectations of staff. Through coaching and working with employees one-on-one, changes were made in several situations, including some employees' decisions to leave MIT.

In addition, the CG Director continued to have responsibility for Administrative and Business Support Services, including the IS finance team, and the various site teams. As a result of attrition, the finance team has been almost completely restaffed since January 1999, and is now well positioned to provide high quality financial analysis services, including financial modeling. The site teams continue to provide administrative support to over 200 IS staff in some six locations across the MIT campus.

Allison F. Dolan

VICE PRESIDENT FOR RESOURCE DEVELOPMENT

The past year has seen a transformation in private support for MIT. The Institute launched a $1.5 billion capital campaign, the most ambitious fundraising effort in history with a spirited celebration in November. The success of our efforts so far underscore the theme for our campaign, "Calculated Risks, Creative Revolutions" as we reached new levels of charitable giving from alumni/ae, friends, foundations, and corporations. Gifts to the campaign since July of 1997 totaled $ 978.5 million at the close of fiscal year 2000.

Private support for fiscal year 2000 totaled $233.6 million and included the following: $226.5 million in gifts, grants, and bequests, and $7.1 million in support through membership in the Industrial Liaison Program. The total compares with $209 million in 1999, $143.9 million in 1998, $133.6 million in 1997, and $130.9 million in 1996. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $12 million. By source, gifts from alumni totaled $113.2 million; non-alumni friends: $23.6 million; corporations, corporate foundations, and trade associations: $59.2 million; foundations, charitable trusts, and other charitable organizations: $28.7 million; and others: $1.8 million.

Expendable and endowed funds were designated as follows: unrestricted, $30.9 million; research and education programs, $67 million; faculty salaries, $29.9 million; graduate student aid, $16.7 million; undergraduate student aid, $31.2 million; undergraduate education and student life, $1.7 million; building construction funds, $33.5 million; and undesignated, $15.6 million.

During the year, there were six promotions in Resource Development, four men and two women. Twenty open staff positions were filled including fifteen women, of whom three were Asian American. Key appointments included Laure Morris as Director of Communications and Donor Relations, Judy Sager as Director of Gift Planning, and Christine Rinaldi and David Woodruff as Co-Directors of the Office of Campaign Giving. Resource Development continued its effort to recruit qualified women and minority candidates by working closely with Human Resources and others to identify new resources from which to draw its applicant pool.

Barbara G. Stowe

CALCULATED RISKS, CREATIVE REVOLUTIONS: THE CAMPAIGN FOR MIT

This year marked the public launch of the Campaign for MIT and the beginning of the next phase of this seven-year $1.5 billion effort. After two years of "silent" fundraising to build a nucleus fund of $549.4 million dollars from MIT's closest and most generous supporters, this first public year was characterized by beginning to engage the broader alumni/ae body in MIT's vision of "Calculated Risks, Creative Revolutions."

As detailed later in this report, five areas of emphasis were key to this first year of outreach. The Office of Individual Giving was restructured into the Office of Campaign Giving (OCG) to personally contact the highest number of alumni/ae possible in the next four years. Key open staff positions were filled including within OCG to increase the number of fund raising staff meeting with alumni/ae. The volunteer structure for the campaign was finalized and volunteers across the country were actively recruited. The initial communications efforts to publicize the Institute's plans for the future and the role of the campaign were inaugurated with the campaign case, the campaign web site, and the campaign launch. Finally, organizational collaboration increased with the Alumni/ae Association and the development staff in each of MIT's schools to better coordinate efforts to raise funds for critical campaign priorities.

When measured across key campaign priorities, MIT raised $104.1 million for faculty chairs, $75.6 million for scholarships and other undergraduate aid, $40.3 million for undergraduate education and student life, $60 million for graduate fellowships, $317.4 million for research and education programs, $181.9 million for construction and renovation, $165.8 million for unrestricted purposes, and $33.5 million remains undesignated.

With the staff, school and volunteer development organizations solidly established and the initial campaign messages articulated, Resource Development is well positioned to carry this early campaign momentum into the remaining campaign years.

Stephen A. Dare

OFFICE OF PRINCIPAL GIFTS

The Office of Principal Gifts, directed by Lucy Miller, manages the efforts of the senior officers of the Institute to secure multi-million dollar gifts from individual prospects, and works to strengthen relationships between the most generous benefactors and the Institute. With the conclusion of the nucleus fund phase of the campaign, the Office of Principal Gifts shifted emphasis from those friends and donors most likely to support the campaign it its early stages to expanding the network to include new ones.

With the addition of one staff member and in collaboration with the Offices of Campaign Giving, Leadership Gifts, Capital Gifts and Legal Affairs, and Foundation Relations, as well as with the development offices in the five Schools of MIT, 45 individuals were cultivated and solicited, and the pool of individual donors with lifetime giving of $1 million or more to MIT increased from 139 to 170.

The Office of Principal Gifts, in collaboration with the Offices of Campaign Giving and Leadership Gifts, managed the activities of the Campaign Steering Committee. Chaired by Campaign Chairman Ray Stata 57 EE, this group of 16 alumni volunteer leaders cultivates and solicits mid- to high-level prospects for gifts exceeding $500,000. With an annual goal of $15 million, they raised $16.4 million in their first year, surpassing their goal by over $1 million.

Lucy V. Miller

OFFICE OF CAMPAIGN GIVING

Established in concert with the campaign kick-off in November 1999, the Office of Campaign Giving (OCG) has primary responsibility for the cultivation, solicitation, and stewardship of major gift prospects and donors. Under the direction of David Woodruff and Chris Rinaldi, more than 4,000 alumni and friends capable of making gifts of $50,000 or more must be solicited by OCG during this campaign. Members of OCG work closely with the administration, faculty, the many areas of Resource Development, the development efforts in the schools and the Alumni/ae Association to coordinate the cultivation and solicitation of these gifts.

To meet this ambitious goal, this first public year of the campaign focused on recruiting and training frontline staff and volunteers while carefully assessing their portfolios to focus on the highest priority prospects. As many staff assumed new regional responsibilities, four new major gift officers joined the staff this fiscal year, making it possible for the office to cover all major regional markets and emerging constituencies.

OCG also supported the efforts of campaign volunteers at all levels. In addition to staffing each member of the Campaign Steering Committee in collaboration with the Offices of Principal Gifts and Leadership Gifts, OCG worked closely with members of MIT's Corporation Development Committee (CDC) while recruiting 75 new volunteers to serve on the Campaign Network (CN). Campaign Network volunteers serve for the duration of the campaign and assist the CDC and members of the staff in efforts to secure major gifts. The CDC and the CN met on campus in the fall for volunteer training in advance of the campaign kick-off; follow-up organizational meetings were held in New York City, Dallas, Chicago, San Diego, and Los Angeles during the course of the year.

Christine M. Rinaldi, David A. Woodruff

OFFICE OF GIFT PLANNING

Directed by Judith V. Sager, the Office of Gift Planning (OGP) is responsible for managing the administration of gifts made through MIT Unitrusts, Gift Annuities, Pooled Income Funds, and bequests.

Gifts for Fiscal Year 2000 totaled $15 million, reflecting an 87.5% increase over the $8 million in gifts reported for Fiscal Year 1999. Half of the goal was reached through gifts by two donors, whose gifts both exceeded $3 million. Four donors made gifts in the $500,000 to $1 million range, which accounted for 20% of all gifts received. The remaining donors made gifts ranging in size from $2,000 to $500,000.

The Office of Gift Planning will work closely with the Office of Campaign Giving, the Office of Individual Giving, the Office of Principal Gifts and the Alumni Association to identify, cultivate, solicit and steward planned gifts to expand the base of capital campaign donors.

Judith V. Sager

OFFICE OF COMMUNICATIONS AND DONOR RELATIONS

The Office of Communications and Donor Relations, known as COMDOR, supports the editorial, cultivation, and stewardship needs of Resource Development and the Campaign for MIT through electronic and print publications, special events and donor follow-up. Under the guidance of Richard P. Anthony and Martha L. Ballard acting as Co-Directors, and more recently under the new leadership of Director Laure A. Morris, COMDOR emphasized two key areas in this fiscal year: the development and communication of key campaign messages, events and publications; and the assessment and start-up of more effective stewardship of campaign donors.

With an eye toward the campaign launch on November 1, development of the campaign case statement and the campaign web site, and preparation for the campaign launch were the top priorities for the first months of the fiscal year. Titled *Knowing Where to Put the X* and *Calculating the Y Axis,* the two-part campaign case statement described MIT's past and current contributions to a global society, while detailing the financial case and its vision for the future. The case statement won the Council for Advancement and Support of Education's Circle of Excellence Award. The themes and ideas of the case statement were echoed and expanded upon in the companion web site that can be found at (http://web.mit.edu/campaign/).

The campaign launch was designed to be a living demonstration of the campaign case. Building momentum over two days, the launch had three parts: campaign volunteer orientation and training during day one; a symposium during day two to showcase the breadth of activity and discovery in education and research across a wide variety of fields at MIT for those alumni/ae and prospects most likely to support MIT philanthropically; followed by an evening gala dinner and dance to celebrate the spirit of the MIT community. Over 60 speakers presented during both days, approximately 100 volunteers attended day one, and approximately 600 alumni/ae and members of the MIT community attended the symposium and dinner gala. By the conclusion of the dinner, those in attendance also cheered and applauded as a new commitment of $100 million was added to the campaign.

Post- campaign launch, COMDOR focused on developing a series of campaign collateral materials: brochures on fellowships, scholarships, and the physical development of the campus; and white papers on specific campaign priorities. A new campaign newsletter for top donors and prospects moved from concept to development by the close of the fiscal year.

In addition for preparing for the campaign launch in all its facets, COMDOR continued to produce a full range of publications while implementing a wide-range of events. The office redesigned *Spectrum*, a 16-page newsletter published three times a year for some 35,000 alumni/ae, faculty and staff; published and distributed *MIT Facts*; produced *Fast Facts*, a monthly electronic newsletter for key volunteers, alumni/ae and friends, and authored the "Donor Profile" series in *Technology Review*, featuring individual donors of planned gifts. Over 30 events for donors, prospects, and volunteers were organized in Cambridge and throughout the country including an April 2000 Campus Visit for key donors and prospects.

Stewardship activities included gift acknowledgement, event planning, facilitation of donor stewardship and the inauguration of the *Catalyst Society*, the society to recognize donors to the Campaign for MIT.

Laure A. Morris

OFFICE OF DEVELOPMENT RESEARCH AND SYSTEMS

Led by Shelley Brown, the Office of Development Research and Systems (ODRS) provides the information infrastructure to Resource Development and its volunteers. This year the office implemented a number of programs within its key strategic areas of research, information management, and technology.

Strengthened by the addition of a staff member, research activities focused on new prospect identification and tracking new information about existing and potential donors. Over 1000 potential individual campaign donors of $50,000 or more have been identified since 1998. The office continued to provide research support for staff and senior officer development activity, adding to its' client roster the members of the Campaign Steering Committee.

Since 1998's successful conversion to ADONIS, (a new alumni/donor software package), work has continued on both developing new modules (such as the Events system used to support the campaign launch) and expanding online and production reporting capabilities. We are well on our way of achieving the goal of making ADONIS the single database of record for fundraising activity and have placed strong emphasis on staff training throughout the Institute.

The technology staff reported complete success in their Y2K compliance. Other activity this year included preparatory and on-site technical support of the campaign launch activities, a department-wide upgrade of all desktop configurations, as well as installation of new versions of Filemaker, Eudora, and Netscape. Regular training programs were conducted for Resource Development staff throughout the department and in the Schools.

Shelley S. Brown

OFFICE OF FOUNDATION RELATIONS AND SCHOOL DEVELOPMENT SERVICES

Under the direction of John S. Wilson, the Office of Foundation Relations and School Development Services develops and strengthens relationships with the foundation community while providing development services to the Institute's five schools. Gifts from private foundations for this fiscal year totaled $28.7 million and continued to provide significant support for the campaign as well as MIT's educational and research programs.

Major grants or pledges include support of the Fund for Public Understanding of Technology and Science; the Museum Art Loan Project; the Starr Asian Internship Program; fellowships in the Department of Brain and Cognitive Sciences; and the Industry Studies Center for the Airline Industry.

The Office of School Development Services (OSDS) provided research support and project management for the fundraising efforts of the five schools, the Libraries, and the Office of Academic Development. OSDS assisted in moving forward MIT's capital campaign priorities, including Undergraduate Student Life, the environmental initiative, and Comparative Media Studies. OSDS also hosted an FYI series on Institute and school-based programmatic initiatives to educate the development staff in the department and in the Schools. Projects managed by OSDS included: the Aero Astro Learning Laboratory for Complex Systems fundraising and dedication events, Neuroscience and Cancer Research initiative planning, and Libraries development support.

John S. Wilson

OFFICE OF CORPORATE RELATIONS

Directed by Karl Koster, the Office of Corporate Relations (OCR), which includes the Industrial Liaison Program (ILP), creates and strengthens mutually beneficial relationships between MIT and other corporations and organizations. This past year OCR supported the efforts of the faculty and senior administration in establishing two more multi-million dollar corporate partnerships; staffed and obtained funding for Institute and international initiatives; and identified corporate support for discrete MIT research and educational programs. In fiscal year 2000, total corporate cash gifts to the Institute reached $59.2 million, up 47% from the previous year. Revenues from the Industrial Liaison Program totaled $7.1 million, up 3% from fiscal year 1999.

OCR continued to emphasize the development of strategic partnerships with key corporations. In fiscal year 2000 these efforts resulted in the signing of a five-year $35 million dollar agreement with E. I. Du Pont de Nemours as well as a five-year $25 million agreement with Microsoft Corporation.

OCR also continued to assist individual faculty and departments at MIT interested in securing corporate support for their programs. New commitments include the Ford Motor Company Fund in the amount of $3 million as well as other corporate partnerships and environmental initiatives.

The development of opportunities to establish collaborative relationships with corporations, MIT consortia and faculty represented another set of accomplishments for OCR during fiscal year 2000. Over 47% of ILP members currently support other activities at MIT, primarily research support.

Staff also worked to implement the OCR Faculty Liaison Plan. They met with department heads and ultimately the entire faculty to understand their goals and objectives and alert them to opportunities available through OCR to connect with the corporate sector. In addition to these meetings, a "Guide for Faculty and Staff" was published to assist faculty in engaging productively with OCR and the ILP.

The OCR recently created a new design for its corporate image, logo and tagline to be applied to a set of collateral material as well as the standard forms, documents and other products in daily use. More information about the Office of Corporate Relations and the Industrial Liaison Program can be found on the World Wide Web at http://ilp.mit.edu/.

Karl F. Koster

ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT

This, my 20th year as executive vice president of the MIT Alumni Association, is arguably the Association's most successful. We have enjoyed the fifth consecutive record year for the Alumni Fund with total gifts of $32.6 million and a record participation in the Parents Fund. Our Technology Day program, "The Future of Atoms in an Age of Bits," received rave reviews from alumni who attended. Successful alumni programs on campus and around the world brought nearly 20,000 people into a closer relationship with MIT. Alumni continue to be keenly interested in academic developments at MIT and turned out in record numbers at events on campus and throughout the world to hear from the more than 100 faculty and senior officers who brought word of MIT. The Association staff continues to find ways to improve our ongoing programs, resulting in the involvement of more and more alumni in MIT related activities.

The Internet has become an increasingly important tool for the Association. Led by Maggy Bruzelius, Director of Alumni Network Services, during this year alumni participation in our email forwarding service increased by 40%; we now serve more than one in three alumni by forwarding more than 65,000 e-mails per day. We merged the five-year-old Association web site with the stand-alone Alumni Network Services (ANS) site creating an easy to use consolidated site. Using online services, alumni signed up for reunions and other Association events, made gifts to MIT, and created e-mail lists to share common interests. We developed online career services (ICAN) and worked with the MIT admissions office to offer online support for the Educational Council. We began negotiations with a vendor to provide online support for the more than ninety MIT clubs around the world.

Over the years, one of the hallmarks of the Association has been the leadership of its volunteer presidents and board members. Last year, I reported the extraordinary benefits of that partnership in the success of the Association. This year our volunteer leadership challenged the staff and other volunteers to examine the implications of becoming a web leveraged organization. This caused the staff and volunteers together to consider how effectively we are using web technology to develop alumni connections with MIT and among the alumni worldwide. In the coming year, as we continue to develop our web strategy, the Internet and the World Wide Web will play an increasingly important and central role in the programs of the Association.

During this past year MIT launched a capital campaign to which the Association has dedicated significant resources and energy. The impressive increase in Alumni Fund participation at every donor level above $100 is evidence that MIT alumni are ready to support this capital campaign commensurate with their capacity. *Technology Review* celebrated its 100th anniversary with a gala celebration and the presentation of the *TR*100, recognition of the best young inventors and entrepreneurs around the world. During this year *Tech Review* continued to expand its circulation to 205,000 as the Association began to consider alternative models for encouraging the continued growth of the magazine. During this year, for the first time in my tenure, the Association president has served on an internal Institute committee. Brian Hughes '77 has been a member of the Council on Educational Technology and members of the Association staff have supported the work of the Council.

ASSOCIATION ON THE INTERNET

During a year in which we have examined carefully the Association's Internet strategy and involvement, I am pleased to report significant new activity using these technologies. In an effort that involved staff representatives from each Association staff unit, we merged the Alumni Association public web site and the secure Alumni Network Services (ANS) web site. This resulted in the creation of an information-rich, fast and easy-to-use consolidated site. Goals for this new site were to integrate the Association web presence targeted toward alumni, to involve alumni in the life of the Institute wherever possible, and to build community by facilitating alumni communications with the Institute and with each other. The staff designed prototype was tested with alumni from a diverse set of classes and range of Internet experiences. The new site is designed to make it easier for alumni to find the information they are looking for.

Another major web related initiative during this year has been investigating the services of commercial vendors to help provide online services to the more than 90 alumni clubs worldwide. We are testing the feasibility of buying a commercial product as opposed to the more common MIT practice of developing services in-house. A vendor has been selected and contract negotiations are underway.

In the fall of 1999, the Provost invited the president of the Alumni Association, Brian Hughes '77, to serve as a member of the Council on Educational Technology (CET). This is especially notable since campus committees seldom include alumni volunteers among their members. Recommendations of this committee include the increased engagement of alumni volunteers in the educational experience of enrolled students. Significant Association staff time has also been allocated to the development of Council recommendations and their implementation.

Our web based online directory is now fully synchronized with the alumni database of record maintained by the Association. This will prove important for the continued development of online services as well as support of the CET initiatives. Procedures are in place to protect the privacy of sensitive information including gift data.

Online alumni services launched in prior years continue to attract new alumni users. E-mail forwarding for life (EFL), formally launched in February 1997, now has 32,000 subscribers for whom MIT forwards over 65,000 email messages each day. This represents a 40% increase over last year. During this year we have continued to refine and improve online directory services, our most popular online service.

ANS launched new services during this year. We created email list services for over 120 existing Association listservs so alumni can subscribe and unsubscribe at their own discretion at any time. Alumni also have the opportunity now to create their own lists with other alumni. This service has proven to be very popular; in only a few weeks alumni created more than 50 lists, ranging over topics that include career networking to living groups to logistics. With partial funding from an alumni gift, ANS created a web based video library featuring presentations from the Alumni Leadership Conference, Family Weekend, and Technology Day. The Association is also a partner in MITWorld with CAES and ILP, slated for launch in fall 2000.

Many other new online features were introduced. Online tracking services for the 1,600 members of the Educational Council were made available in the fall. This year the Institute Career Assistance Network (ICAN) went online and saw an increase in numbers of volunteer mentors to 2,400. We improved the search capacity of this program by adding SIC codes to make it easier to find appropriate mentors. The Alumni Externship Program was put online to allow alumni to submit externship opportunities more easily and for students to select situations for which they wish to apply. During this year we provided ANS guest accounts for administrators. These accounts allow administrators quickly and easily to search the online directory. Support for increased numbers of volunteer class and club webmasters includes the webmaster tool kit as well as telephone and email interactions with staff. Other online tools include club leadership tools and events calendars as well as tools for department services.

As the web has become more and more ubiquitous, the Association has begun to integrate the web and email into all services. Online event registration options have become routine; online giving is being promoted more often; e-mail is used to communicate with recent graduates, for soliciting class notes, and to notify alumni of regional events. With a vigorous agenda for becoming web leveraged, the Association expects to use the Internet more effectively in the coming year to build a worldwide community of engaged alumni.

ALUMNI FUND

Strong annual giving from MIT alumni set a record for the fifth time in as many years with the Alumni Fund reporting $32,567,000 from 29,619 alumni plus a number of other non-alumni donors. This 13% increase over fiscal year 1999 was achieved under the leadership of a new staff volunteer partnership which includes Paula Olsiewski CM'79, Alumni Fund chair; Gregory Moore '73, Fund Goals Committee chair; Elizabeth A. Garvin, Director of the Alumni Fund, and Rosemarie Resnik, Director of Alumni Activities. The Parents Fund, included in the Alumni Fund totals, turned in another participation record with gifts of $320,000 from 1,130 parents, a 10% increase in donors over fiscal year1999.

A major factor contributing to this remarkable result was the strong increase in gifts at every gift level over $100. For the first time, MIT has more than 100 donors with Fund credit of $100,000, an increase from 89 last year to 112 this year. During this year the Fund recognized for the first time donors of $10,000 or more as Killian Society Patrons. We reported a 13% increase in donors at this level and a 5% increase in other Killian Society donors at $5,000 to $9,900.

The chart below shows Fund results against goals as well as changes from the prior year. Graduate alumni participation numbers remain strong with gifts from 11,000. Gifts from graduate only alumni increased by $1.4 million to $11.5 million in the Fund. The decrease in overall participation is probably a result of undergraduate dissatisfaction with announced changes for housing students on campus as well as some negative impact of large campaign gifts on donors at lower levels. Not reported on this chart is the impact of strong matching gifts that showed a 15% increase in dollars and an 18% increase in the number of gifts.

Table 1. Goals And Measurements

	FY1999 Results	FY1999–2000 Goals	FY2000 Goals	FY2000 FINAL RESULTS
Total Alumni Fund	***$28.8M***	***+1.2M***	***$30M***	***32.6M***
Undergraduate				
# Donors to Fund	19,123	+477	19,600	18,625
# Donors ≥ $500	3,237	+88	3,325	3,510
% Donors ≥ $500	16.9%	+.1%	17%	19%
# First-time Donors	647	+103	750	705
Graduate Students Exclusively				
# Donors to Fund	11,243	+157	11,400	10,994
# Donors ≥ $500	1,101	+49	1,150	1,276
% Donors ≥ $500	9.8%	+.3%	10.1%	11.8%
# First-time Donors	828	+22	850	1,006
TOTAL				
# Donors to Fund	***30,366***	***+634***	***31,000***	***29,619***
# First-time Donors	***1,475***	***+125***	***1,600***	***1,711***
Total Giving ≥ $2,000				
# Donors ≥ $2,000	1,196	+104	1,300	1,386
% Donors ≥ $2,000	3.9%	+.3%	4.2%	4.8%
Parents Fund				
Total $'s	$431,000	($31,000)	$400,000	$320,000
# Donors	1,034	+166	1,200	1,130

Reunion giving continues to be one of the cornerstones of the Alumni Fund solicitation program. The reunion class gifts for this year reached over $34.5 million, with much of those gifts going towards the core needs of the Institute such as scholarship aid, faculty support, the UROP program and facilities development. The year-end numbers for reunion classes, reported below, include record results turned in by the 25th and 30th classes. The senior class gift doubled participation over last year, due largely to the Fibonacci Challenge issued by Association president, Brian Hughes '77. The Alumni Fund staff worked hard this year to position programs so that more alumni would be solicited for increased gifts, including working with the Tech Caller program to fill in for gaps in volunteer efforts. For example, one student caller's solicitation of a 30th reunion class alumnus resulted in a $1.25 million gift!

Table 2. Reunion Giving

Class Year	Reunion Year	Gift Total	Participation
1930*	70	$1,229,480	32%
1935*	65	$5,092,998	53%
1940	60	$4,205,005	57%
1945	55	$928,205	52%
1950*	50	$6,391,304	64%
1955	45	$921,027	53%
1960*	40	$4,792,237	66%
1965	35	$1,900,738	51%
1970	30	$3,666,964	55%
1975*	25	$5,154,817	63%
1980	20	$252,640	46%
1985	15	$166,007	38%
1990	10	$70,540	31%
1995	5	$20,398	23%
1999*	Senior	$29,989	24%
Total		**$34,822,349**	

**five-year campaigns*

The Alumni Fund phonathon program continues to account for about one-third of all alumni donors to the Fund. The Tech Caller Program this year broke records for total gifts, pledges, credit card gifts, dollars per caller and total alumni contacted.

The Alumni Fund staff assumed management of the Katharine Dexter McCormick '02 Society, which gained over 100 new members, for an increase of about 20%.

Capital Campaign
The Alumni Association, particularly through the Alumni Fund, worked in close collaboration and cooperation with Resource Development staff in preparation for the launch of the capital campaign. In this first public year of the campaign, the Association sent the first campaign notice for most alumni with an emphasis on the continuing importance of annual giving and the value of every gift to the success of this campaign. The centennial issue of *Technology Review* was also sent to all alumni. New initiatives and enhanced programming for the campaign includes an increased emphasis on reunion giving and young alumni participation. We launched a Young Alumni Campaign Committee chaired by Sang Han '93 and Annalisa Weigel '94. Staffing for the Parents Program has been increased to add a major donor prospect program and we have developed a program for increasing graduate alumni giving at Alumni Fund gift recognition levels. Annual fund solicitations have been focused more directly on campaign priorities. New initiatives in direct mail, phonathons and online solicitations reflect a movement toward more targeted marketing of the Alumni Fund.

VOLUNTEER PARTNERSHIPS
The success of the Alumni Association depends in large measure on the effective partnership among MIT's more than 4,000 volunteers and the Association staff. Brian G. R. Hughes'77, the president of the Association, has most ably represented these volunteers this year. During this year Hughes visited with fifty-one clubs in Asia, Europe and many US cities. Hughes was appointed by Provost Robert Brown to serve as a member of the Council on Educational Technology. This is the second time in two years that alumni volunteers have been recruited to serve on what are primarily Institute internal committees. This kind of volunteer involvement in the Institute is most welcomed by the Association.

Under Hughes' leadership, the Association's volunteer Board of Directors undertook an in-depth review of four key program areas: career services, club programs, lifelong learning, and online alumni services. The outcome of these deliberations was an assignment for staff to develop a plan for becoming a web-leveraged organization over the next 12–24 months. In another key initiative the Board agreed to the restructuring of *Technology Review.*

During this year more than 120 alumni served as members of Association national boards and committees. These committees have been led by the following volunteers: Paula J. Olsiewski CM'79, Alumni Fund Board; Gregory E. Moore '73, Alumni Fund Goals Committee; James A. Lash '66, Alumni Network Services Advisory Council; Gary Schweikhardt GM'73, Awards Committee; Steven G. Finn '68 Committee on Nominations for Corporation Visiting Committees; Peter S. Miller '64, Enterprise Forum Board; Robert A. Muh '59, National Selection Committee; Joost P. Bonsen '90, Technology Day Committee; DuWayne J. Peterson '55, *Technology Review* Board.

The Association is responsible for the selection of fifteen members of the MIT Corporation. The National Selection Committee selects and recruits these alumni. In addition, many other Corporation members are alumni, with the result that more than 80% of current Corporation members are MIT alumni. The Association also selects six alumni members for each of the 26 Corporation Visiting Committees, with the result that nearly 300 alumni served on these committees this year.

The National Selection Committee named the following alumni to MIT and Association governance positions, beginning on July 1, 2000 for fiscal year 2001.

MIT Corporation for five-year terms:
Brian G. R. Hughes '77
Linda C. Sharpe '69
James A. Lash '66

Association president-select to serve as president fiscal year 2001:
Paul Rudovsky '66

Association vice presidents for two-year terms:
Gregory K. Arenson '70
M. William Dix '67

Association district directors for two-year terms:
Bonny S. Kellermann '72
Sze-Wen Kuo '73
Peter A. Klock '65
Dale Schain Krouse '71
Richard I. Bergman '55
Monica S. Alcabin '83

Association young alumni representative for two-year term:
Dora L. Gallo CP'92

Each fall, the Association invites MIT leadership to join in the celebration and recognition of the significant alumni volunteer contributions to the welfare of the Institute. This year the annual Alumni Leadership Conference (ALC), held October 1–3, 1999, featured our very successful MIT on the Road program with presentations from three representative faculty members: Dr. Nancy Hopkins, "The Genetic Age;" Dr. Simon Johnson EC'89, "The World Financial Crisis 1997–98: Who was to blame and what should we do about it?" and Prof. Samuel Jay Keyser HM, "The Language of Poetry/The Poetry of Language."

During the business session, alumni welcomed Ray Stata '57, chair of the Campaign Steering Committee, who gave volunteers a preview of the upcoming capital campaign. Pre-ALC activities included a general volunteer briefing, a report by Erin Hester '82 who served as a member of the Institute Residence Redesign Steering Committee, and workshops for class and club officers, reunion volunteers, Sloan alumni volunteers, Enterprise Forum leaders, the Alumni Interfraternity Council, and members of the Educational Council.

An annual feature at the luncheon during the ALC is the presentation of the Association awards for outstanding volunteer leadership and performance. Honorary membership was presented at the Technology Day luncheon on June 5, 1999. Awards presented at the ALC luncheon were as follows:

Bronze Beaver Award for distinguished service to MIT, the highest Association recognition honor:
Robert L. Blumberg '64
Gerald J. Burnett '64
George F. Clifford '48
Jorge E. Rodriguez '60
Linda C. Sharpe '69

Harold E. Lobdell '17 Distinguished Service Award for sustained alumni relations service of special depth:
Hubert I. Flomenhoft AA'47
Henry H. Houh '89
Ernest H. Knight '28
Frederick J. Kolb '38
James A. Lash '66
Cynthia Helsel Skier '74
J. Thomas Toohy '49
G. Mead Wyman '62

George B. Morgan '20 Award for excellence in service to the Educational Council:
Richard Collarini '71
Ninamarie Maragioglio '77
Henry N. McCarl '62
Jerome Schooler '59

Henry B. Kane '24 Award for exceptional fundraising service and accomplishment:
Henry B. Barg GM'73
Herbert E. Grier '33
Martin N. Rosen '62
John H. Wills '26,
Albert O. Wilson '38

Presidential Citation Award given to alumni volunteer groups for distinguished service:
Building 20 Event
MIT Club of Puget Sound
Class of 1978 20th Reunion Committee,
Association of MIT Alumnae – 125 Years of Women at MIT
Class of 1983 15th Reunion and Reunion Gift Committees

Honorary Membership:
Barbara J. A. Gordon

ASSOCIATION PROGRAMS AT MIT

Central to the mission of the Association is fostering connections among alumni as well as between alumni and the Institute. Our objectives during this past year have been to build a stronger alumni connection by offering each alumnus opportunity for substantive engagement with the Institute and its community. Tech Reunions is the Association activity that engages more alumni and friends than any other single event. Again in June 2000, Association volunteers and staff offered dozens of events attended by nearly 3,000 alumni and their guests. The 50th reunion class of 1950 had a record attendance of more than 460 and enthusiastically posted close to 200 photographs on the class developed web site immediately after the reunion. This year the staff has endeavored to add "more MITness" to our programs. Examples include scheduling more MIT related tours and more Camp Tech children's activities on campus.

The second annual Great Court Gala, bigger and better than last year, was a resounding success among the alumni, graduating students, their parents, MIT faculty, administrators, and their guests. They all celebrated the MIT community in the tent on Killian Court, in the piano bar in the Bush Room, and in the disco down in Lobby 13. It is hard to describe the strong sense of community and celebration represented by this event. Perhaps the parade of the 50th reunion class into the tent and the video of MIT reunions through the years give an indication of the wonder of this event.

The Technology Day program provided the traditional drink from the MIT firehose. This year's program, "The Future of Atoms in an Age of Bits," asked, "In an increasingly networked world, how will our physical environment and our role in it evolve?" The committee asserted that the program "will explore the impact of this technological transformation [the Internet] on our physical world." Introduced by William J. Mitchell, dean of the School of Architecture and Planning, the program included presentations by Josef Sheffi CE'78, professor Course I and director of the Center for Transportation Studies; Rodney A. Brooks, professor Course VI and director of the Artificial Intelligence Laboratory; and Rosalind W. Picard EE'91, associate professor in Media Arts and Sciences. Dean Mitchell moderated a lively question period following the presentations.

Well attended afternoon sessions were presented on three topics: "The New Neighborhood: Living and Working in Virtual Communities" moderated by Judith S. Donath AR'87, assistant professor, Media Arts and Sciences; "Clicks and Mortar: the Future of the Physical U." moderated by David Warsh, columnist with *The Boston Globe*; and "Emerging Innovations and Entrepreneurship" moderated by John W. Poduska '59, chairman of Advanced Visual Systems. This year's program enjoyed high attendance and high praise from all alumni participants. Other highlights of Tech Reunions and Tech Day included the Welcome Reception in the tent on Kresge Oval, the traditional MIT Night at Pops, the alumni memorial service in the MIT Chapel, the Reunion Row won by the class of 1965, and the Alumni Challenge games also won by the class of 1965.

Through its support of Senior Week activities, the Association offered a transition from student status to alumni status. The Alumni Activities Expo, held in Lobby 10 in May, also provided an opportunity for graduating students to learn about the benefits available to alumni. Another vehicle for students to glimpse the world of alumni is the Student Ambassadors program which this year involved 31 students in 31 alumni events for a total of 272 placements, an average of nine students per event. Annual Senior Dinners brought seniors and alumni together on seven nights in February with the Vests at the Presidents House.

The Alumni Association manages the Parents Program for the Institute. In addition to the Parents Fund mentioned above, the Parents Program hosts Family Weekend, held this year on October 15–17. A record 500 families, many of whom come each year, attended this popular program. The program this year featured a panel discussion "Looking to the Future" moderated by President Vest with the deans of MIT's five schools or their representatives. Keeping to this theme, ten faculty members, at least one from each school, gave presentations on their work in two concurrent sessions. Dozens of activities filled the three day event, illustrating the best of MIT through lab tours, athletic events, panel discussions, and performances.

Another feature of the Parents Program is the Parent Connectors volunteer group, which has grown by 80 new parent volunteers for a total of 165 parents who have agreed to be contacted by parents of newly admitted students.

Anniversary celebrations, planned and executed with assistance from Association staff, added interesting events to the Association's campus programs this year. During the Alumni Leadership Conference in October, 1999, the Association of MIT Alumnae (AMITA) held a 100th anniversary party with recollections from Emily V. (Paddy) Wade '45, Shirley Jackson '68, Beth Marcus '79, Cady Coleman '83 and Bhuvana Kulkarni '00. On the same night alumni celebrated the rededication of Alvar Aalto's Baker House which had been restored and renovated on the occasion of its 50th anniversary. On March 21–22, 2000, the Department of Civil and Environmental Engineering

celebrated its 100th anniversary with the dedication of a professorship in honor of Martha and Donald Harlemann CE '50. The Center for Real Estate celebrated its 15th anniversary with support from the Association on September 30–October 1, 1999.

ASSOCIATION SERVICES WORLDWIDE

The centerpiece of the Association's activities for alumni around the world is our vigorous MIT clubs program in 93 locations. During this year 733 alumni served as officers in these clubs working in partnership with association staff to provide connections to MIT for thousands of alumni. Three clubs celebrated anniversaries this year: Washington, DC (100th), Great Britain (50th), Princeton, NJ (25th). In addition, the Association supports the 55 alumni who serve as officers in affinity groups: Association of MIT Alumnae (AMITA), Black Alumni of MIT (BAMIT), Chinese Alumni of MIT (CAMIT), Bisexual, Gay and Lesbian Alumni (BGALA), and the Arab Alumni Association of MIT (AAAMIT).

Among the most popular club programs is the Alumni Seminars, an Association service that makes it possible for MIT faculty and administrators to bring a flavor of today's MIT to alumni. This service, in high demand once again this year, conducted 88 alumni seminar programs with 57 faculty and senior administrators participating. Sixty events were sponsored by US clubs and 28 by non-US clubs.

Begun in January 1998, the MIT on the Road (MOTR) program continues to be popular among alumni as well as among the faculty who are asked to make presentations. This year nearly 300 alumni and guests attended MOTR seminars in Seattle, Houston and the Delaware Valley. Among the twelve faculty presenters this year, nine were making alumni presentations for the first time.

To serve alumni volunteers in Europe, we hosted in September 1999 the third European Club Officers Workshop in Brussels. The first Middle Eastern conference was held in March 2000 in Cairo, Egypt with more than 150 people in attendance.

Nearly 625 MIT travelers went on one of thirty-two trips offered by the Alumni Travel Program. Trips this year featured twelve MIT faculty and meetings with local alumni in places like Saudi Arabia, China, and South Africa. An innovative research based trip to Venice was planned with Professor Donald Harlemann who arranged meetings with local authorities on the Venice flood; this special MIT feature was very popular and we plan similar partnerships with other faculty. Also new this year was a family trip to Alaska, which sold out almost immediately, as so many of our trips do. Two of the three family trips planned for fiscal year 2001 were already sold out at year-end. This new market for alumni travel seems quite promising.

For over twenty years, the MIT Enterprise Forum has been helping entrepreneurs start and grow successful technology-based businesses. During the year the Forum increased its chapters to 23 with the addition of Atlanta, Austin, Japan, and Switzerland. The centerpiece of the Forum programming from MIT is the Satellite Broadcast Series, which produces three programs each year. The programs are broadcast before a live audience on campus to remote sites around North America. The first program on October 6, 1999, featured John Dean as panel moderator for, "What Private Equity Investors Are Looking For." On January 20, 2000, Joe Hadzima '73 was moderator for "Structuring Venture Capital Deals." The final program held on May 31, 2000 as part of Tech Reunions, presented Howard Anderson as moderator for "Building Value through Entrepreneurship." These programs reached a typical audience of 2,000 people in more than 20 separate venues in addition to those attending on campus. Establishment of many receiving sites involved the cooperative efforts of a Forum chapter, an alumni club and, in several instances a Sloan Club, with some sites signing on for all three presentations.

TECHNOLOGY REVIEW

The year 1999 marked the 100th anniversary of *Technology Review*, celebrated with a well-attended *TR*100 event that included a symposium and a gala award celebration on November 4, 1999. To celebrate *Technology Review*'s 100 years of continuous publishing, the magazine selected 100 young innovators under age 35 by recognizing their potential as future leaders in their fields. Many of those selected have since been given other prestigious awards. Several were named Howard Hughes Medical Institution investigators; three have gone on to receive McArthur Foundation "genius" awards. Over 500 key influencers, founders of companies, Fortune 500 CEOs, entrepreneurs, alumni, and the media attended these events. Hosted by noted journalists Bill Moyers and Lesley Stahl, the *TR*100 symposium was sponsored by Dupont, Motorola, Lucent Technologies, PriceWaterhouse Coopers, and Credit Suisse First Boston. Press coverage included live television and radio coverage by CNBC and NPR.

In "year two" of the new *Technology Review*, the magazine continued to enjoy increasing success, capped by significant revenue increases from approximately $5.5 million in fiscal year 1999 to $9.5 million this year. Circulation grew to a record high of 205,000 with a total audience of 750,000. Editorial highlights for the past year

include the special "*TR*100" issue in November/December, and the May/June "Beyond Silicon" issue which coincided with a national conference of the same name convened by *Technology Review* in June at the Kennedy Library in Boston.

In fiscal year 2000, the magazine made a significant investment in its fledgling conference and event division, *Tech Review Live!* Under its auspices, more than 15 executive briefing events were held in cities across the country before an aggregate audience of more than 1,100 people and two major conferences were held. *MITNews* was the proud winner of a Silver Medal for General Excellence from CASE and *Technology Review*'s marketing team won the coveted Izzy Direct Marketing award.

Although *Technology Review* has long been a vital part of the Alumni Association's services to MIT alumni, the continued success of the magazine as an MIT service to a broader public has led the Association to propose a new management structure for the magazine. Much energy during this year has been devoted to examining options that will enable the continued growth of the magazine.

SUPPORTING FUNCTIONS

At the end of fiscal year 1999, there was a major staff reorganization and reassignment of management responsibilities, creating a senior management team. A good deal of effort and a great deal of time during much of the year was dedicated to building this team. Working closely with the personnel and financial officers as well as the information systems staff we began to make the transition. Reallocation of staff and operating budgets was accomplished early in the year and the new leadership team ably handled operations in support of staff in five locations across campus. Genevieve Hammond, personnel officer for many years, resigned and we were pleased to welcome Jacquie Granville, personnel and operations administrator, to the team.

Taking a fresh look at operations and support functions resulted in the creation of an operations and support services unit, headed by Joseph Recchio, that includes the personnel function, networking support, information systems (including data entry), mail services, and a variety of other liaison functions with MIT administrative offices. During the year the information systems group recorded 51,000 gifts and made nearly 30,000 changes in directory information in addition to those changes made online directly by alumni themselves. The Operations Working Group and the Technical Strategy Group, made up of staff representatives from across the Association, worked with staff in this new unit to accomplish all necessary functions during the year. Major unit resources were dedicated to collaboration with the ANS staff and other MIT-IT/IS staff in supporting the development and maintenance of online services for alumni.

The areas of information services, personnel, financial services, and operations are essential to the effective functioning of the organization. Staff in these areas work in the background and provide strong support to the many activities of the Association, including *Technology Review*. During this year continued training on the new alumni records database and on the Institute's new financial system was also handled by this staff. Working with the Audit and Budget Committee of the Association Board of Directors, the financial officer continued to refine financial reporting tools to meet Board and management needs.

Staffing issues continue to require attention with many staff changes occurring during this year. Forty-one new staff members joined the Association (TR, 13; other AA, 28); thirty people left the staff (TR, 8; other AA 22); and nine people were recognized for exceptional performance.

Alumni surveys have become increasingly important at MIT. Evaluating alumni experience and learning about alumni opinions and needs is relevant to Institute planning for curriculum innovation as well as for strategic decisions. This year Association staff worked on alumni surveys with six departments and student groups. Working with other Institute offices, we participated for the first time in the CoFHE (The Council on the Financing of Higher Education) survey with 65 other institutions nationwide. The Association also cooperated with McKinsey Consulting which conducted a survey among electrical and computer science engineering graduates in nine major engineering schools across the country. The Council on Educational Technology conducted focus groups among alumni in Boston and San Francisco with assistance from Association staff.

More information about the Association and its activities can be found on the World Wide Web at http://web.mit.edu/alum/ and http://www.techreview.com/.

William J. Hecht '61

Reports
to the
President

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